



## **A green certificate market for developing renewable energy technologies - pros et cons.**

**Morthorst, P.E.**

*Published in:*  
ENER Bulletin

*Publication date:*  
2002

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Morthorst, P. E. (2002). A green certificate market for developing renewable energy technologies - pros et cons. *ENER Bulletin*, (25), 41-47.

---

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

## **ENER Forum 3:**

**Successfully Promoting Renewable Energy Sources in  
Europe**

**Budapest, Hungary, 6-7 June 2002**

**The European Network for Energy Economics Research**

**Thematic Network of the European Union Fifth Framework Programme (ENERGIE)**

**December 2002**

*The European Network for Energy Economics Research (ENER).*

*Thematic Network of the European Union Fifth Framework Programme (ENERGIE)*

**ENER Forum 3: Successfully Promoting Renewable Energy Sources in Europe.  
Budapest, Hungary, 6-7 June 2002**

**Abstract.**

The objective of the 3<sup>rd</sup> ENER Forum was to discuss the prospects of the RES-E directive and to identify criteria for successfully promoting RES in Europe among relevant stakeholders, such as governments, energy companies, regulators, and consumers, in EU and Accession countries.

In detail the following issues were treated:

- Experiences with different types of instruments (feed-in tariffs, bidding/tendering, tradable green certificates, rebates, Green Pricing, environmental taxes) depending on technologies and countries.
- Interference of different supporting schemes on public involvement in the RES businesses and, thus, on the public acceptance; influence of different supporting schemes on the type of investor (Large companies vs small cooperatives vs individuals).
- Interaction of financial resources available from JI and CDM projects and ET and national or EU money coming from different RES supporting mechanisms.
- The consequences of the proposal for a EU Directive establishing a scheme for greenhouse gas emission allowance trading within the Community (COM(2001)581final) on the deployment of renewable energy sources and their interactions with the EU directive on renewables (2001/77/EC) to the EU member and accession countries will be investigated.
- Future prospects of different types of strategies will be discussed for single countries and technologies, trans-boundary and for the whole EU/Europe.

**Cover**

Map generated by ArcView 3.2 from Environmental Systems Research Institute Inc. (ESRI).

**Layout**

Poul Erik Grohnheit, Risø National Laboratory.

**Member institutes**

Centro de Estudos em Economia da Energia dos Transportes e do Ambiente, **CEEETA**

Universidade Técnica de Lisboa, Lisboa, Portugal

Centre for Energy Policy and Economics, **CEPE**

ETH Zürich, Zürich, Switzerland

Netherlands Energy Research Foundation, **ECN**

Policy Studies on Energy and Environment, Petten, Netherlands

Institute of Power Systems and Energy Economics, Energy Economics Group, **EEG**

Vienna University of Technology, Vienna, Austria

**Energia Klub**, Budapest, Hungary

ENVIROS, s.r.o. **ENVIROS**, Prague, Czech Republic

Fraunhofer Institute for Systems and Innovation Research, Co-ordinator of the ENER Network, **FhG-ISI**

Karlsruhe, Germany

Polish Foundation for Energy Efficiency, **FEWE**

University of Metallurgy and Mining, **UMM**  
Krakow, Poland

Grupo Interuniversitario de Estudios Energéticos, **GIEE**

Universidad Politécnica de Madrid, Madrid, Spain

Istituto di Economia delle Fonti di Energia, **IEFE**

Università Commerciale L. Bocconi, Milano, Italy

Institut d'Economie et de Politique de l'Energie, **IEPE**

Université des Sciences Sociales de Grenoble, Grenoble, France

“Jožef Stefan” Institute, **IJS**

Energy Efficiency Centre, Ljubljana, Slovenia

Institute for Nuclear Research and Nuclear Energy, Bulgarian

Academy of Science, Energy Systems Analysis Department

**INRNE-BAS**

Black Sea Regional Energy Centre, **BSREC**

Sofia, Bulgaria

Institute for Physical Energetics, Department Analysis and Optimisation of Energy Systems, **IPE**, Riga, Latvia

Institute for Power Studies and Design, **ISPE**

Bucharest, Roumania

Lithuanian Energy Institute, Laboratory of Energy Systems Research, **LEI**, Kaunas, Lithuania

Department of Environmental and Energy System Studies, **Lund**  
University of Lund, Lund, Sweden

**PROFING**, Bratislava, Slovak Republic

Risø National Laboratory, Systems Analysis Department, **RISØ**  
Roskilde, Denmark

Estonian Institute for Sustainable Development - Stockholm

Environment Institute Tallinn Centre, **SEI-Tallinn**, Tallinn, Estonia

Science and Technology Policy Research, **SPRU**

University of Sussex, Brighton, UK

Study Centre on Technology, Energy and Environment **STEM**

University of Antwerp, Antwerp, Belgium

Under the current contract, the ENER Network co-operates with the international organisation GLOBE Europe, Brussels on the interaction with parliamentarians concerning sustainable development

ISBN 87-550-3136-6

ISSN 1608-7062

Print: Pitney Bowes Management Services Denmark A/S, 2002

## Contents

The European Network for Energy Economics Research (ENER).....	4
Preface .....	5
Abbreviations.....	6

### Summary of the 3rd ENER Forum

How to promote renewable energy systems successfully and effectively <i>Reinhard Haas, Claus Huber (EEG, Vienna University of Technology), Wolfgang Eichhammer (ISI), Ole Langniss (Lund University), Arturo Lorenzoni (IEFE), Reinhard Madlener (CEPE), Philippe Menanteau (IEPE), Poul-Erik Morthorst (Risø), Alvaro Martins (CEEETA), Anna Oniszk (EC BREC), Joachim Schleich (ISI), Adrian Smith (SPRU), Emiel van Sambeek (ECN), Zoltan Vass (Energia Klub), Aviel Verbruggen (University of Antwerp, STEM).....</i>	7
--	---

### Opening of the ENER Forum 3:

Sustainable energy systems in the 6 <sup>th</sup> RTD Framework Programme of the EU (2002–2006) <i>Domenico Rossetti di Valdalbero and Benat Bilbao Osorio, European Commission, DG Research (Energy programme) .....</i>	12
--	----

### Session 1: Promoting RES in Europe – The state-of-the-art

EU strategy and instruments for promoting renewable energy sources <i>Karl Kellner, DG TREN, European Commission .....</i>	16
Survey on and review of promotion strategies for RES in Europe <i>Reinhard Haas, Energy Economics Group, Vienna University of Technology, Austria. ....</i>	19
Transaction Cost Economics of Regulations to foster Renewable Energy Sources in the Electricity Sector <i>Ole Langniss, Department of Environmental and Energy Systems Studies, Lunds Universitet .....</i>	28
Regulatory and Institutional Innovation for the Promotion of Renewable Energy Use <i>Reinhard Madlener, CEPE – Centre for Energy Policy and Economics, Zurich, Switzerland and Eberhard Jochem, CEPE and Fh-ISI – Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany .....</i>	34

### Session 2: Pros and Cons of various promotion strategies

A green certificate market for developing renewable energy technologies – pros et cons. <i>Poul Erik Morthorst, Risø National Laboratory, Roskilde, Denmark.....</i>	41
---	----

Feed-in tariffs versus quotas: how to promote renewables and stimulate technical progress for cost decrease ? <i>Philippe Menanteau, Dominique Finon, Marie-Laure Lamy, IEPE, CNRS / Université Pierre Mendès-France, Grenoble, France .....</i>	47
---	----

Efficiency criteria for promoting electricity generation from renewables <i>Claus Huber, Reinhard Haas, Thomas Faber, Gustav Resch, Energy Economics Group, Vienna University of Technology. ....</i>	55
--	----

The European Dimension of National Renewable Electricity Policy - The Dutch Experience <i>Emiel van Sambeek, Energy research Centre of the Netherlands.....</i>	61
--	----

Tradable green certificates in Flanders (Belgium) <i>Aviel Verbruggen &amp; Johan Couder, UA (University of Antwerp) STEM, Antwerpen, Belgium.....</i>	70
---	----

The Challenge for Tradable Green Certificates in the UK <i>Adrian Smith and Jim Watson, SPRU, University of Sussex, UK. ....</i>	79
---	----

Leaving REFIT for the green certificate market: a jump in the dark? <i>Arturo Lorenzoni, Università L. Bocconi, Milano, Italy .....</i>	84
--	----

### Session 3: Promoting RES: stakeholders point-of-view

The effect of renewable energy supporting strategies on society. The issue of public acceptance <i>Andreas Wagner, EWEA, Germany.....</i>	89
The experience of Spanish renewable energy developers and investors <i>Manuel Bustos, Spanish Renewable Energy Association- APPA, Barcelona - Spain.....</i>	91

### Session 4: Promoting RES in accession countries

How to justify and define a feed-in tariff? A debate and decisions in Slovenia, 2002 <i>Mihael G. Tomšič, Jožef Stefan-Institute, Slovenia ...</i>	95
Is current RES support policy in the Czech Republic sufficient and efficient? Barriers and challenges <i>Jaroslav Jakubes and Miroslav Maly, Enviros, Prague, Czech Republic .....</i>	100
Renewable energy supporting strategies in Poland <i>Anna Oniszk-Popławska EC Baltic Renewable Energy Centre EC BREC/IBMER, Warsaw, Poland.....</i>	105
<b>Programme.....</b>	111
<b>List of Participants .....</b>	112

## **The European Network for Energy Economics Research (ENER)**

Energy policies, traditionally national preserves, have become increasingly determined in international areas, and nowhere more so than in the European Union. In view of these movements towards more international and more environmentally responsive energy policies, researchers from IEFE (Institute of Energy Economics, Bocconi University, Milan), IEPE (Institute of Energy Policy and Economics, University of Grenoble), and SPRU (Science and Technology Policy Research, University of Sussex) made a cooperation agreement in September 1985 to promote better communication among the groups and stimulate joint research activities. Since then the activities of the Network have been financially supported by the European Commission's Directorates General for Energy and for Research.

ENER has since then grown to include FhG/ISI (Fraunhofer Institute of Systems and Innovation Research, Karlsruhe) in 1988, CEEETA (Centre for the Economic Study of Energy, Transport and the Environment, Lisbon) in 1989, GIEE (Inter University Group on Energy Studies, Madrid) in 1992. In 1995, the Systems Analysis Department of Risø National Laboratory, Roskilde, the Policy Study Unit of the Netherlands Energy Research Foundation (ECN), Petten, and the Study Centre on Technology, Energy and Environment (STEM, University of Antwerpen) joined the network. Lund University, Department of Environmental and Energy System Studies became a member in 1996, Energy Economics Group at Vienna University of Technology (EEG)) in 1997.

With the current series of Forums the ENER Network is opening up to the accession countries with participants from Poland (Polish Foundation for Energy Efficiency FEWE Center in Krakow / University of Mining and Metallurgy UMM), Czech Republic (ENVIROS), Hungary (Energia Klub), Romania (Institute of Power Studies and Design ISPE) and to Switzerland (Centre for Energy Policy and Economics CEPE).

These Forums are financed as a Thematic Network under the European Union Fifth Framework Programme (ENERGIE). This contract started by the end of 2000, and it covers four Forums until 2003. A proposal for extension submitted for the last call of the Fifth Framework Programme in December 2001 was successful. The extension aims at integrating a larger number of accession country partners in the activities through two additional Forums, and to enhance interaction with stakeholders from Parliaments by two common Forums with the international organisation GLOBE Europe.

The new participants are from Bulgaria (INRNE-BAS, in co-operation with BSREC), Estonia (SEI-Tallinn), Latvia (IPE), Lithuania (LEI), Slovak Republic (Profing), and Slovenia (IJS).

## Preface

The objective of the Forum of the European Network for Energy Economics Research ENER is to create a debate between relevant stakeholders in academia, governments, industry and NGOs in important fields in relation to energy, climate change and economics. It also aims at strengthening the links between national centres in energy/environment policy and economics research in particular with Central and Eastern European countries in view of their accession to the EU. It is hoped that the common activities with the partner institutes in those countries as well as with stakeholders participating in the events organised by ENER will contribute to continued co-operation in the same way as the one initiated among ENER institutes in the current EU Member States one decade ago.

For this purpose a Thematic Network was set up, financially supported by DG Research under the ENERGIE Programme. The Thematic Network co-ordinated by the Fraunhofer Institute of Systems and Innovation Research FhG-ISI/Germany gathers 16 institutes from EU Member Countries, Central and Eastern European Accession Countries and Switzerland, which bring in their skills and experiences in both qualitative and model-based analyses. Within the Thematic Network, four ENER Forums are to be held, all of which in the EU accession countries, under the common theme of *Paths for Energy Policy between Policy Challenges and Market Domination*.

The first ENER Forum 1 was held in Krakow, Poland, February 2001 on the topic *Integrating the Kyoto Mechanisms into the National Framework*. The proceedings of the ENER Forum 1 can be found in the ENER Bulletin 23.01.

The second ENER Forum 2 was held in Prague, the Czech Republic, November 2001 on the topic *Monitoring the progress of the implementation of the EU Gas and Electricity Directives: Are European markets becoming competitive?*

The proceedings of the ENER Forum 2 are compiled in the ENER Bulletin 24.01.

This ENER Bulletin contains the papers presented at the ENER Forum 3 held in Budapest, Hungary, June 2002 on the topic *Successfully Promoting Renewable Energy Sources in Europe*.

The objective of the ENER Forum 3 has been to stimulate the discussion and exchange of knowledge on the progress, barriers, difficulties and prospects of the deployment of RES technologies among relevant stakeholders, such as governments, energy companies, regulators, TSOs and consumers, in EU Member and EU Accession Countries.

In four sessions, the participants addressed a range of issues related to the deployment of RES technologies in the EU Member States and Accession Countries.

The ENER Bulletin provides the text of most of papers presented during the two days of the ENER Forum 3 and also the summaries and major conclusions form the individual sessions. All presentations – also from speakers who have not provided a text paper - are available (as PowerPoint or pdf file) on the ENER web site: [www.eu.fhg.de/ENER/Enerhome.htm](http://www.eu.fhg.de/ENER/Enerhome.htm)

## Abbreviations

CCGT	Combined cycle gas turbine
CDM	Clean Development Mechanisms
CHP	Combined heat and power
CO <sub>2</sub>	Carbon dioxide
DLTR	Department for Transport, Local Government and the Regions, UK
DG	Directorate General (European Commission)
DTI	Department of Trade and Industry (UK)
EC	European Commission
EEG	Erneubare Energie Gesetz (Germany)
EIB	European Investment Bank
ERA	European Research Area
ET	Emission trading
EU	European Union
EWEA	European Wind Energy Association
FIT	Feed-in tariff
GHG	Greenhouse gas(es)
IEA	International Energy Agency
IP	Integrated project (EU 6 <sup>th</sup> Framework Programme)
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
MPS	Maximum price standard
MSW	Municipal solid waste
NAS	New Associated States
NETA	New Electricity Trading Arrangement (UK)
NFFO	Non-Fossil Fuel Obligation (UK)
NGO	Non-Government Organisation
NIS	Newly Independent States
NoE	Network of Excellence (EU 6 <sup>th</sup> Framework Programme)
OECD	Organisation for Economic Co-operation and Development
PPA	Power Purchase Agreement
PV	Photovoltaics
RES	Renewable energy sources
RES-E	Renewable energy sources – electricity
RET	Renewable energy technologies
ROC	Renewables Obligation Certificates (UK)
RPS	Renewable portfolio standards (Texas)
SME	Small and Medium sized Enterprises
TCE	Transaction cost economics
TGC	Tradable Green Certificates
TWh	Tera Watt hours (10 <sup>9</sup> kWh)
WTP	Willingness to pay
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WTP	Willingness to pay

## Summary of the 3rd ENER Forum:

### How to promote renewable energy systems successfully and effectively

Reinhard Haas, Claus Huber (EEG, Vienna University of Technology), Wolfgang Eichhammer (ISI), Ole Langniss (Lund University), Arturo Lorenzoni (IEFE), Reinhard Madlener (CEPE), Philippe Menanteau (IEPE), Poul-Erik Morthorst (Risø), Alvaro Martins (CEEETA), Anna Oniszk (EC BREC), Joachim Schleich (ISI), Adrian Smith (SPRU), Emiel van Sambeek (ECN), Zoltan Vass (Energia Klub), Aviel Verbruggen (University of Antwerp, STEM)

#### Introduction

The main objective of the 3rd ENER Forum was to discuss the following core questions:

- What are the pros and cons of various promotion strategies?
- What are the criteria for successfully promoting electricity produced from renewable energy sources (RES-E)?
- What are the most promising future instruments for promoting RES in EU and in access countries?

In detail the following issues were tackled:

- Experiences with different types of instruments (feed-in tariffs (FITs), bidding/tendering, tradable green certificates (TGC), rebates, Green Pricing, environmental taxes...) depending on technologies and countries;
- Impact of different supporting schemes on public involvement in the RES businesses and, thus, on the public acceptance; influence of different supporting schemes on the type of investor (Large companies vs small cooperatives vs individuals);
- Future prospects of different types of strategies were discussed for single countries and technologies, and for the entire Europe

The major perceptions of this meeting as well as the most important policy conclusions and recommendations for energy policy makers are compiled in this summary<sup>1</sup>.

#### Survey on strategies

To increase the market penetration of RES strategies have been implemented in various European countries in recent years. The core objective of strategies to foster RES-E is the substitution of sustainable energy use for non-sustainable energy forms, and thus a wider deployment of (active) RES capacities. Therefore, the major focus must of course always be to **trigger investments in new capacities**. But the maintenance, upscaling, improvement of existing capacities has also to be borne in mind.

Objectives derived from this core objective are: (i) to stimulate technological progress; (ii) to trigger learning effects with respect to investment costs; (iii) to minimise administration and transaction costs; (iv) to maintain public acceptance regarding RES technologies.

The debate on the promotion of RES focuses most on the comparison between price-driven, (e.g. FITs) and capacity-driven (e.g. TGC-based quotas) strategies, see Table 1. These two approaches aim at the same target, but start from different points: in the first case the PRICE is set and the quantity is decided by the market; in the second case (which includes TGC-based quotas and bidding procedures) the QUANTITY is set and the price is decided by the market, see Fig. 1a and 1b.

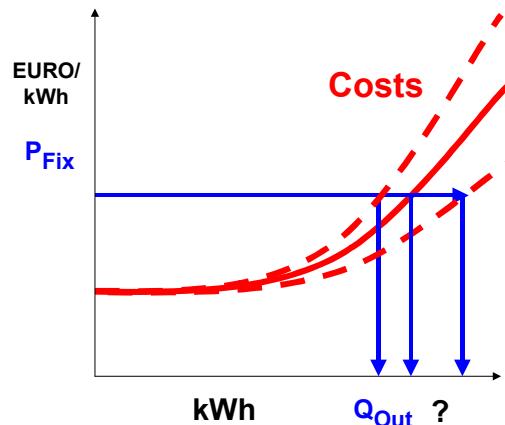


Fig. 1a. How a feed-in tariff works

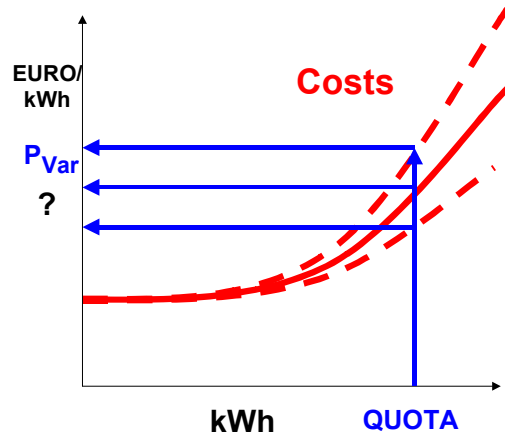


Fig 1b. How a TGC-based quota works

Table 1 provides a classification of regulatory strategies for encouraging the use of RES.

Table 1. Fundamental types of regulatory strategies

	Price-driven	Capacity-driven
<b>Investment focused</b>	<ul style="list-style-type: none"> <li>• Rebates</li> <li>• Tax incentives</li> </ul>	<ul style="list-style-type: none"> <li>• Bidding</li> </ul>
<b>Generation based</b>	<ul style="list-style-type: none"> <li>• Feed-in tariffs</li> <li>• Rate-based incentives</li> </ul>	<ul style="list-style-type: none"> <li>• Quotas/TGC</li> </ul>

<sup>1</sup> The statements compiled in the following represent a consensus within the ENER Network while on some questions differences in perception and analysis persisted.



Table 2. Past, current and in the near future planned regulatory promotion strategies for electricity from RES in EU and some NAS countries

		Large hydro	Small Hydro	"New" RES (Wind, PV, Biomass, Biogas, Landfill gas, Sewagegas, Geothermal)	Municipal Solid Waste
Austria	current	No	8% current quota (based on TGCs)	4% non-tradable quota until 2008 in combination with regional-specific FITs and other instruments (investment subsidies, bidding etc.)	No
	proposed	No	Non-tradable quota: 9% for small hydro in 2008, 4% for "new" RES in 2008 – in combination with national harmonised minimum FITs. In addition regional-specific instruments (investment subsidies, bidding, higher guaranteed FIT)		Biogenic fraction accounts to "new" RES
Belgium		No	Flemish region: 3% quota (based on TGCs) in 2004 for RES (excl. MSW), escalating penalty (7.5 c€/kWh in 2002, rising to 12.5 c€/kWh in 2004); Wallonia: 5% quota (based on TGCs) in 2004 for RES & CHP; Brussels region: No support scheme yet		
Denmark	current	No	Mix of strategies (FITs, tax credits etc.)		No
	proposed	No	Planned 200?: Quota system based on TGCs for RES		No
Finland		No	No	Wind: Investment subsidies by 30-40% (on a case-by-case basis) and tax refund (0.7 c€/kWh); Biomass: Tax relief (3.1 c€/kWh)	No
France		No	FITs : 5.5-6.0 c€/kWh	FITs, in more detail: Wind: 4.8-8.4 c€/kWh on a 15 year average <sup>2</sup> ; PV: 15.25-30.5 c€/kWh <sup>3</sup> ; Biomass: FITs in progress	4.5-5.0 c€/kWh
Czech Republic		No	FITs : 5.0 c€/kWh Inv. subsidies for selected projects	FITs, in more detail: Wind / Geothermal: 10.0 c€/kWh, Biogas / -mass: 8.3 c€/kWh, Solar / PV: 20.0 c€/kWh Investment subsidies for selected projects	No
Germany		No	FITs: 6.65-7.67 c€/kWh	FITs, guaranteed for 20yr., in more detail FITs for new installations in 2002 are <sup>4</sup> : Wind: 6.1-9 c€/kWh; <sup>5</sup> PV: 48.1 c€/kWh, Biomass: 8.6-10.1 c€/kWh <sup>6</sup> ; Geothermal: 7.16-8.95 c€/kWh; Sewage-, Landfill- and marsh gas: 6.65-7.67 c€/kWh	No
Greece		No	FITs (at al level of 75-90% of the selling tariff, higher on islands, lower on the mainland) and a mix of other instruments (30% investment subsidies, tax credits, reduced loans etc.)		No
Ireland		No	Bidding Programme – Currently: AER V with technology bands and price caps for small and large wind, small hydro and biomass; Furthermore: tax relief		No
Italy		2% quota (based on TGCs) for all new RES (incl. large hydro and MSW) – with rolling redemption <sup>7</sup> (8yr.), unclear penalty enforcement; Investment subsidies ("10,000 roofs-programme") for PV; structural funds for Wind			
Luxembourg		No	No	FITs and investment subsidies for Wind, PV and Biomass	No
Poland	current	7.5% of RES electricity in 2010 starting from 2.4% in 2001, FITs 5-7 c€/kWh (voluntary – max. duration of 3-5 yr.). Legal framework weak - only regulation, no Act (no long-term PPAs), no punishment = no stability for investors,			No
	proposed	No	7.5% of RES in total primary balance in 2010 and 14% in 2020 in RES Strategy - no sound legal framework		No
Portugal		No	FITs and investment rebates for Wind <sup>8</sup> , PV, Biomass, Small hydro		No
Spain		<50MW: FITs on top of market price (premium!): 2.99 c€/kWh		FITs on top of market price (premium!), in more detail (only premium): Wind: 2.89 c€/kWh, PV: 18-36 c€/kWh, Biomass: 2.55-2.77 c€/kWh	FITs-premium: 2.15 c€/kWh,
Sweden	current	-	<1.5 MW: 15% Investment grant, 0.09 SEK/kWh operation grant	Biomass: 25 % Investment grant; Wind: 10-15 % Investment grant, 0.27 SEK/kWh operational support (0.09 SEK/kWh environmental premium + 0.18 SEK/kWh energy tax refund) on top of low market price (1.5 c€/kWh)	-
	proposed	-	Target 10 TWh increase by 2010 = 15.3 % quota in 2010		
Netherlands		Mixed strategy (green pricing and tax exemptions <sup>9</sup> ); Investment subsidies for wind			
United Kingdom		Quota (based on TGCs) by 2010 for all RES (exc. large hydro and MSW); quota starts at 3% in 2002, rising to 10.4% by 2011 – penalty set at 3 p/kWh (5 c€/kWh). Tax exemption ("climate change levy") for RES (0.66 c€/kWh). Investment arants for offshore wind (€ 68 Mio. For demo projects, plus € 16 Mio. from "New Opportunities fund")			

<sup>2</sup> 8.4 c€/kWh for the first 5 years and then between 3.1 and 8.4 c€/kWh depending on the quality of the site – project size limited to 12 MW.

<sup>3</sup> 30.5 c€/kWh for Corse and Overseas Departments

<sup>4</sup> For some RES, guaranteed FIT for new installations decrease over time: For biomass 1% per year, for PV 5% per year, for wind 1.5% per year.

<sup>5</sup> 9 c€/kWh for the first 5 years and then between 6.1 and 9 c€/kWh depending on the quality of the site.

<sup>6</sup> The guaranteed FIT depends on the size of the biomass plant (8.6 c€/kWh for plants <500kW, 10.1 c€/kWh for plants >5MW); similar regulations are given for geothermal as well as sewage-, landfill- and marsh gas plant.

<sup>7</sup> In general only plants put in operation after 1 April 1999 are allowed to receive TGCs for their produced green electricity. Moreover, this allowance is limited for the first 8 years of operation (rolling redemption)

<sup>8</sup> E.g. wind producer receive a stepped FIT of 4.3-8.3 c€/kWh, plus investment grants up to 30%

<sup>9</sup> Customers of green electricity are exempt from paying the energy tax (currently about 5 c€/kWh).

### The state-of-the-art on currently implemented strategies

Currently in various European countries different strategies are in force. Table 2 provides an overview of strategies by country for the major technology categories addressed

It can be seen from this table that FITs are currently the prevailing instrument, followed by rebates, tax incentives, tendering systems, and green tariffs.

An analysis by country reveals the patchwork on implemented strategies and ongoing changes.

In **Austria** currently no promotional system exists for electricity from large hydropower, municipal solid waste and sewage biomass. With respect to electricity from "new RES" a quota not based on TGCs is implemented by law. It requires that 4% of final electricity consumption is generated from "new" RES by 30 September 2008.

Currently, the promotional systems to meet this quota are different in the nine Austrian provinces and consist of mixes between FIT, rebates, and bidding systems. For small hydro power a TGC based quota system has been introduced in 2001, which as so far not fulfilled the expectations. The major problems are that there is no liquid market and that the penalties (different in every of the nine provinces) are at the margin by far too low to stimulate investments in new capacities. Currently, even the association of small hydro power generators, which has initially demanded the TGC-based quotas is in favour to abolish this system completely.

In **Belgium** up to 2002 RES-E generators benefit most from an add-on payment of 4.96 c€/kWh above the (low) price of about 2.75 c€/kWh on average paid by the utilities for feed-in power. Also direct investment subsidies (e.g. in the Flemish region 75% of investments in PV in 2001 have been subsidised, but limited to a small fund) co-exist as well as better feed-in conditions (only for PV a revolving meter is allowed). Flanders enacted a TGC-system from Jan. 1, 2002 onwards; Wallonia is planning for a different system.

**Denmark** has more or less abandoned its FITs and tax-incentives system by the end of 2000 and announced to switch to a TGC-based quota system. This led to the fact that currently Denmark is destroying part of its technological and socio-economic progress made so far e.g. for wind turbines. Even more damaging is the fact, that the TGC system has not been implemented yet. The uncertainty is a high obstacle to investment.

In **France** until 2001 a bidding system for wind power (Eole 2005) was in force, which turned out not to be very successful. In 2001 the system was changed towards a stepped<sup>10</sup> FIT.

In **Germany** a FIT was adopted unanimously by Parliament in 1990. In 1991, the so-called "Stromeinspeisungsgesetz" went into force. As a consequence of

the German electricity market being fully liberalised in 1998, this law had to be adjusted, and it was replaced in April 2000 by the Renewable Energy Act. It is a federal law determining FITs by RE technology. This strategy has been very successful so far, making Germany the number one world wide in wind energy use, with a total installed capacity of 10.000 MW (on Aug. 8, 2002). The financial "burden" due to this strategy is equally distributed over all electricity customers.

While the EC was until 2001 very reluctant against this law a decision of the European Court of Justice confirmed that the German law is in line with the provisions of the EU Treaty, more specifically with the State Aid rules, since it does not constitute state aid given the fact that it is financed directly by the customers.

**Italy** after a decade under a fixed tariff scheme (CIP6 contracts, with a premium for 8 years to new RES-E projects admitted in a list, which will keep on until 2012), a portfolio has been created in 2002. All the production from fossil fuels, excluding CHP and small companies producing less than 100 GWh, and import of electricity, have an obligation to cover 2% of their sales with new renewable energy production. New RES-E are projects come on line after April 1999. They have the right to receive the TGCs for the first eight years of operation. The fulfilment of the obligation is facilitated by the creation of a Green Certificate Market in operation from 2002. Producers not complying with the portfolio requirement will have to pay a fine equal to 1.5 times the highest price paid in the previous year on the TGC market. The 2% quota will grow by 0.125% per year from 2005 to 2012.

The most obscure system is currently practiced in **The Netherlands**. While the principle is good (see van Sambeek 2002, this issue) the fact that also the import of green electricity from existing power plants is allowed leads to the fact, that a huge amount of money is wasted for providing "windfall profits" for German, Swiss, and Austrian hydro and wind power utilities.

In **Portugal** since 1998 FITs are in force for all RES except large Hydropower and Municipal Solid Waste (MSW). More recently, in 2001, very interesting FITs have been defined and the mandatory percentage of self financing has been relaxed which explains the existing boom for wind energy projects. It is expected that the actual wind potential of 3000 MW will all be used by 2007.

In **Spain** in 1998 the „Real Decreto 2828/1998“ was established. It is based on FITs by technology. Although it is delivering good results in some technologies (it brought Spain into the TOP 2 of European Wind generators within three years) it is not enough to overcome other barriers. The main barriers for RES development is essentially a lack of integrated political will, e.g. too low prices for biomass. A lack of transparency and objectivity in the grid connection framework and too different regional procedures make a global RES approach difficult.

In **Sweden** for the period 1 July 1997 to 30 June 2002 investment grants were available for electricity from wind power, small-scale hydro plant and biomass.

<sup>10</sup> The terminology "stepped FIT" will be explained in the last section of this summary, No. 8..

The highest investment grants are available for biofuel-fired CHP. Subsidies of around (358 €/kW) are granted for investments that provide a new contribution to electricity generation, but may not exceed a maximum of 25% of the investments. Grants for wind power and environmentally friendly small-scale hydro plants were available amounting to 15% of the investment for new facilities over 200 kW capacity.

In addition, two other mechanisms exist for supporting small renewable energy projects in Sweden. The first is guaranteed power purchase contracts with local utilities. Prior to electricity market reform, holders of regional power concessions were required to purchase electricity at the utility's avoided cost from all small power projects with generation capacities of up to 1500 kW. This requirement continues to exist under the new law, in which local distribution utilities must still purchase all electricity generated by projects of less than 1500 kW within their service territories. The price now paid to small generators is equal to the residential tariff plus a credit for reduced transmission and distribution losses minus reasonable costs for utility administration and profit.

The other support mechanism is an environmental bonus paid from the government. Small-scale RES-based electricity production is favoured by lower or zero energy taxation. In addition biofuels are exempted from sulphur taxation.

In the **UK** until 2000 tendering systems have been used to promote RES. The most well known of these promotion strategies is the Non-fossil Fuel Obligation (NFFO) in England and Wales. Similar schemes have been set up for Scotland (Scottish Renewables Order - SRO) and Northern Ireland (NI-NFFO). This strategy has recently been changed and renamed so as to increase the amount of renewables capacity.

In 2003 in the UK a TGC-based quota system will be introduced. The quote rises from 3% this year to 10.4% in 2011. Also, large hydro and MSW schemes are not eligible for the Renewables Obligation, and are therefore excluded.

### General conclusions

From the presentations and discussions the following recommendations and conclusions for EU policy makers are most important:

1. Without additional policy measures, many EU member countries are likely to fail reaching the national targets for electricity from renewable energy sources (RES-E) indicated in the EU Directive (2001/77/EC). In case of NAS (new accession states) it is necessary to start to create their policy framework in order to be prepared of adapting the mentioned Directive.
2. Sufficient prices for RES electricity, long-term stability of support mechanism, fair and easy access to the electricity grid and clear building codes are very crucial factors each to be addressed by successful RES support mechanisms.
3. There is no single, universally applicable "best" support mechanism or policy for the bundle of dif-

ferent technologies known as RES. A mix of policy instruments needs to be tailored to the particular RES and the specific national situation to promote the evolution of the RES from niche to mass markets. This policy mix needs to evolve with the technology.

4. More important than the choice of the system is the proper design and monitoring of the support system adopted; in this respect the functionality, stability and continuity of a policy-support system are crucial features.
5. Not all RES are at the same level of development. They are not all sitting on the shelf ready to be plugged into the electricity system. Some RES, such as wind, are almost competitive in mass electricity markets. Others are viable in niche markets, like PV, biomass, while others are still in the early stages of technological evolution, e.g. wave power. Support mechanisms should take this into account by permitting larger producers' surpluses in earlier stages of market introduction to make possible manufacturers' investments in R&D as well as in manufacturing facilities. In later market stages, these surpluses should be reduced. At the same time excessive (windfall) profits should be avoided. Given that no major uncertainty is introduced that could displace investment a stepped FIT provides such an incentive. Stepping FITs (e.g. by decreasing the feed-in tariffs over time according to the expected learning curve and economies of scale and scope effects of both new renewable and conventional energy technologies, and/or the discriminating of the feed-in tariffs according to some technology performance indicators) can lead to comparable cost reductions with FITs as model calculations show.
6. It is important that a promotional system makes the proper distinctions between existing (fully depreciated) and new capacities, and that the distinctions are suited to the technology segment of the RES-market. Depending on the development targets of the particular RES-technology and depending on the promotional instruments in use, the distinction is of more or lesser importance. Thus for a quota system, the quota should preferably be applied to new capacities, and for a TGC system, primarily certificates for new systems should qualify for trading;
7. The support mechanism of any instrument should be guaranteed for and restricted to a certain time frame, e.g. 10 years.
8. Feed in tariffs (FIT), RES quotas and bidding systems are all exclusively governing the relation between the RES generator and the electricity supplier. That means in principle that competition among RES plant manufacturers exists regardless of the choice of support mechanism.
9. In case of new RES technologies it is likely that the procedures set up by the authorities and the le-

- gal framework are not adequate enough to deal with a lot of small energy generation projects. Therefore it is necessary to harmonise the authorising process in the particular country.
10. With a given target of a certain amount of RES at a certain time, neoclassical economic theory predicts an EU-wide quota exclusively for new RES installations with an accompanying international trading scheme (further to be referred to as 'RES quota') to be the most efficient approach in terms of minimising additional costs. Does an EU-wide harmonised promotion strategy make sense? If so under which conditions? For European wide trade of certificates with maximum efficiency gains an EU-wide harmonisation is undoubtedly necessary for an European RES quota. Currently, however, it appears unlikely that such a harmonised strategy will be implemented in the short-term because:
    - a. trade in certificates will not contribute to national CO<sub>2</sub>-reduction unless it is closely co-ordinated with an emission quota-system – even then it is the emission quota which give the CO<sub>2</sub>-reduction
    - b. the value of CO<sub>2</sub>-reduction will not be included in the price of TGCs. Thus the only reason to track TGCs is to enforce the development of sustainable long-term technologies
    - c. presently the TGC-systems introduced in EU-MS are very different. To introduce a harmonised system will be very difficult.
  11. Moreover, FIT can easily be changed towards an international RES quota if the quota refers to new capacities only. Yet, strong efforts will be needed to adapt/harmonise existing national RES quotas towards an international RES quota! Currently the support systems are rather diverging than getting harmonised
  12. Regarding the argument that for FITs and rebates subsidies are provided while the exertion of market forces drives quota-based TGC systems it has to be stated that that in all promotion strategies finally the public pays! In voluntary programmes some people pay more, some people pay less. If cost-driven strategies are implemented these subsidies (rebates, FITs) are paid by the electricity users and the same applies for capacity driven strategies. The major goal for policy should be to find strategies which minimises public costs.
  13. If a (national) support scheme exists fostering reasonable market development of RES-E at reasonable (not too high) compensation costs it cannot be recommended to change the (national) system! Efficiency gains possibly incurred with a change are unlikely to outweigh risks due to insufficient implementation and policy uncertainty in that case. Therefore, this choice of a strategy has to take into account the current state of promotion and the possible future dynamics for retaining the current system vs. changing to another system!
  14. When switching from one support system to another, the increased investors' risk caused by regulatory uncertainty should be taken into consideration. In this respect a clear commitment by policy-makers, and excellent planning of the transition phase and design of the new system is absolutely crucial.
  15. In the scientific discussion trade within RES quotas are usually modelled with spot markets. However, this seems to be inappropriate since long-term investments in RES power plants will be secured by long-term power purchase contracts in the most cases as Transaction Costs Economics predicts. Preliminary experience with RES quotas in Texas and Australia confirms this prediction. Thus, efficiency gains from tradable RES quotas in comparison with a fixed feed-in tariff (FIT) might be not as large in practise as envisaged by Neoclassical Economics.
  16. Incentive-based promotion schemes alone are insufficient to create a sustainable RES-E market development; innovative regulation and institutions fostering institutional change and training and education of the relevant actors are also of high importance; in this context a systemic perspective provides useful, which allows to identify and tackle the important barriers and latent drivers simultaneously and in a comprehensive way.
  17. Organising bidding auctions, verifying RES power plants, issuing and redeeming certificates as well as adapting and tuning continuously RES regulation are causing transaction costs. A proper comparison of promotion mechanisms has to take into account these transaction costs when making an appraisal of the effectiveness. Moreover, operators of small RES power plants are more vulnerable to high transaction costs than operators of large RES power plants.
  18. Finally, empirical evidence has shown that in a real world with 'real politicians' carefully designed stepped feed-in tariffs are the preferable instrument for a mature technology (e.g. wind).

## Opening of the ENER Forum 3: Sustainable energy systems in the 6<sup>th</sup> RTD Framework Programme of the EU (2002–2006)

*Domenico Rossetti di Valdalbero and Benat Bilbao  
Osorio, European Commission, DG Research (Energy  
programme)*

FP6 represents a deliberate break with the past FPs with regards to its ambition, scope and instruments to be used in its implementation. It adopts a new philosophy, aimed at achieving a greater focus on questions of European importance and a better integration of research efforts on the basis of an improved partnership between the various actors in the European Research Area (ERA).

ERA aims to an open co-ordination with the different National Programmes and other European organisations, creating a more comprehensive European Research Policy.

FP6 will be the key tool for supporting the ERA. Its main components work on the direction of *integrating, structuring and strengthening the foundations of the ERA*.

The budget which is primarily allocated for implementing this new FP is 17.5 € billions, which represents 3.9% of the EU's budget and approximately 6% of the EU's public civilian research investment. The application of this budget pursues the objective of financing the different components/ activities of the FP<sup>11</sup>:

1. Focusing and integrating Community Research
2. Structuring ERA
3. Strengthening the foundations of ERA

The first part (more than € 13 billions) is the most important one and cover the following priorities:

1. Life sciences, genomics and biotechnology for health
2. Information Society Technologies
3. Nanotechnologies and nanosciences, knowledge-based multifunctional materials, new production processes and devices
4. Aeronautics and Space
5. Food quality and safety
6. Sustainable development, global change and ecosystem
7. Citizens and governance in a Knowledge-based society

In addition to these seven research priorities, there are other "specific activities covering a wider field of research" including the part related to "Supporting policies".

## Sustainable energy systems

In addition to Euratom (940 € millions) carrying out research in fusion and fission, the "Sustainable energy systems" programme (810 € millions) addresses the following strategic objectives:

- reduction of greenhouse gases and pollutant emissions;
- security of energy supply;
- increased use of renewable energy;
- enhanced competitiveness of European industry.

Achieving these objectives in the short term requires a large-scale research effort to encourage the deployment of technologies already under development and to help promote changes in energy demand patterns and consumption behaviour by improving energy efficiency and integrating renewable energy into the energy system.

The longer term implementation of sustainable development requires also an important RTD effort to assure the economically attractive availability, of energy, and overcome the potential barriers to adoption of renewable energy sources and new carriers and technologies such as hydrogen and fuel cells that are intrinsically clean.

Within this context, the different research priorities can be divided in<sup>12</sup>:

### *Research activities having an impact in the short and medium term*

Community RTD activity is one of the main instruments, which can serve to support the implementation of new legislative instruments in the field of energy and to change significantly current unsustainable patterns of development. These patterns are characterised by growing dependence on imported fossil fuels, continually rising energy demand, increasing congestion of the transport systems, and growing CO<sub>2</sub> emissions, by offering new technological solution which could positively influence consumer/user behaviour, especially in the urban environment.

The goal is to bring innovative and cost competitive technological solutions to the market as quickly as possible through demonstration and other research actions aiming at the market, which involve consumers / users in pilot environments, and which address not only technical but also organisational, institutional, financial and social issues.

- Clean energy, in particular renewable energy sources and their integration in the energy system, including storage, distribution and use.

The aim is to bring to the market improved renewable energy technologies and to integrate renewable energy into networks and supply chains, for example by supporting stakeholders who are committed to establishing "Sustainable Communities" employing a high percentage of renewable energy supplies. Such actions will adopt innovative or improved technical and/or socio-economic

<sup>11</sup> See Annex 1, page 15 for a detailed budget breakdown.

<sup>12</sup> COM(2002)43final

approaches to “green electricity”, heat, or biofuels and their integration into energy distribution networks or supply chains, including combinations with conventional large scale energy distribution.

- Energy savings and energy efficiency, including those to be achieved through the use of renewable raw materials.  
The overall objective is to reduce the demand for energy by 18% by the year 2010 in order to contribute to meeting the EU’s commitments to combat climate change and to improve the security of energy supply. Research activities will focus in particular on Eco-Buildings to generate energy savings and improve environmental quality as well as quality of life for occupants. “Polygeneration” activities will contribute to the Community target of doubling the share of co-generation (CHP) in EU electricity generation from 9% to 18% by 2010. Equally, it will improve the efficiency of combined production of electricity, heating and cooling services, by using new technologies such as fuel cells and integrate renewable energy sources.
- Alternative motor fuels.  
The Commission has set an ambitious target of 20% substitution of diesel and gasoline fuels by alternative fuels in the road transport sector by the year 2020. The aim is to improve the security of energy supply through reduced dependence on imported liquid hydrocarbons and to address the problem of greenhouse gas emissions from transport. In line with the Communication on alternative fuels for road transportation, short term RTD will concentrate on three types of alternative motor fuels that potentially could reach a significant market share: biofuels, natural gas and hydrogen.

*Research activities having an impact in the medium and longer term*

In the medium and longer term, the objective is to develop new and renewable energy sources, and new carriers such as hydrogen which are both affordable and clean. Also; they can be well integrated in a long term sustainable energy supply and demand context both for stationary and for transport applications. Furthermore the continuing use of fossil fuels in the foreseeable future requires cost-effective solutions to the disposal of CO<sub>2</sub>. The goal is to bring about further reduction in greenhouse gas emissions beyond the Kyoto deadline of 2010. The future large-scale development of these technologies will depend on significant improvement in their cost and other aspects of competitiveness against conventional energy sources, within the overall socio-economic and institutional context in which they are deployed.

- Fuel cells, including their applications:  
These represent an emerging technology which is expected, in the longer term, to replace a large part of the current combustion systems in industry, buildings and road transport, as they have a higher efficiency, lower pollution levels and a potential

for lower cost. The long term cost target is 50 €/kW for road transport and 300 €/kW for high-durability stationary applications and fuel cell/electrolysers.

- New technologies for energy carriers/transport and storage, in particular hydrogen  
The aim is to develop new concepts for long term sustainable energy supply where hydrogen and clean electricity are seen as major energy carriers. For H<sub>2</sub>, the means must be developed to ensure its safe use at an equivalent cost to that of conventional fuels. For electricity, decentralised new and in particular renewable energy resources, must be optimally integrated, within inter-connected European, regional and local distribution networks to provide secure and reliable high quality supply.
- New and advanced concepts in renewable energy technologies:  
Renewable energy technologies have, in the long term, the potential to make a large contribution to the world and EU energy supply. The focus will be on technologies with a significant future energy potential (photovoltaics and biomass) and requiring long-term research (including the integration of renewables), by means of actions with high European added value in particular to overcome the major bottleneck of high investment costs and to make these technologies competitive with conventional fuels.
- Capture and sequestration of CO<sub>2</sub>, associated with cleaner fossil fuel plants:  
Cost effective capture and sequestration of CO<sub>2</sub> is essential to include the use of fossil fuels in a sustainable energy supply scenario, reducing costs to the order of 30€ in the medium term and 20€ or less in the longer term per tonne of CO<sub>2</sub> for capture rates above 90%.

A limited part on Energy Research will also be carried out under the “Specific activities covering a wider field of research” (supporting policies), which complement research within Thematic Priority 6.

These activities have, among others, the objective of underpinning the economic potential and cohesion of a larger and more integrated EU. Two specific items should be underlined for energy:

- Development of tools, indicators and operational parameters for assessing sustainable transport and energy systems performance (economic, environmental and social);
- Forecasting and developing innovative policies for sustainability in the medium and long term).

### **Instruments for implementation**

In order to carry out these activities, FP6 envisages the use of a wider range of new instruments, which will allow a better implementation of the different research priority. The main instruments are the new Networks of Excellence and Integrated Projects<sup>13</sup>, the Article 169

<sup>13</sup> <http://europa.eu.int/comm/research/fp6/networks-ip.html>

(Community participate in the joint implementation of national research programmes) and the “Stairway of Excellence” (traditional instruments like the shared-cost RTD projects, the Co-operative research projects for SMEs and the Co-ordination actions).

Both Networks of Excellence and Integrated Projects will be implemented in the seven priority thematic areas of the Framework Programme and, in duly justified cases, in research areas supporting policies and anticipating scientific and technological needs.

#### *Networks of Excellence*

The purpose of Networks of Excellence (NoE) is to strengthen and develop Community scientific and technological excellence by means of the integration, at European level, of research capacities currently existing or emerging at both national and regional level. Each network will also aim at advancing knowledge in a particular area by assembling a critical mass of expertise. They will foster co-operation between capacities of excellence in universities, research centres, enterprises, including SMEs, and science and technology organisations. The activities concerned will be generally targeted towards long-term, multidisciplinary objectives, rather than predefined results in terms of products, processes or services.

A NoE will be implemented by a joint programme of activities involving some or, where appropriate, all of the research capacities and activities of the participants in the relevant area to attain a critical mass of expertise and European added value. A joint programme of activities could aim at the creation of a self-standing virtual centre of excellence that may result in developing the necessary means for achieving a durable integration of the research capacities. A joint programme of activities will necessarily include those aimed at integration, as well as activities related to the spreading of excellence and dissemination of results outside the network.

The size of the network may vary according to the areas and subjects involved. As an indication, the number of participants should not be less than half a dozen. On average, in financial terms, the Community contribution to a network of excellence may represent several million € per year.

#### *Integrated Projects*

Integrated Projects (IP) are designed to give increased impetus to the Community's competitiveness or to address major societal needs by mobilising a critical mass of research and technological development resources and competence. Each IP will be assigned clearly defined scientific and technological objectives and should be directed at obtaining specific results applicable in terms of, for instance, products, processes or services. Under these objectives they may include more long-term or “risky” research.

IP will comprise a coherent set of component actions which may vary in size and structure according to the tasks to be carried out, each dealing with different aspects of the research needed to achieve common

overall objectives, and forming a coherent whole and implemented in close co-ordination.

They will be carried out on the basis of overall financing plans preferably involving significant mobilisation of public and private sector funding, including funding from EIB and collaboration schemes such as Eureka.

All the activities carried out in the context of an IP will be defined in the general framework of an “implementation plan” comprising activities relating to:

- research, and as appropriate technological development and/or demonstration;
- management, dissemination and transfer of knowledge with a view to promoting innovation;
- analysis and assessment of the technologies concerned, as well as the factors relating to their exploitation.

In pursuit of its objectives, it may also comprise activities relating to training researchers, students, engineers and industrial executives, in particular for SMEs; support for the take-up of new technologies, in particular by SMEs and information and communication, and dialogue with the public concerning the science/society aspects of the research carried out within the project.

The combined activities of an IP may represent a financial size ranging from several million € to several tens of millions of €. However, the size of projects is not a criterion for exclusion, and access to new instruments is ensured for SMEs and other small entities.

#### **Conclusion**

Research into Sustainable Development is one of the priorities of the European Union. Both the Euratom Programme and the “Sustainable energy systems” cover actions regarding Energy research to be seen in close co-operation with the two other components of the Priority 6, i.e. “Sustainable surface transport” and “Global change and ecosystems”.

New instruments (NoE and IP) have been created to achieve higher levels of efficiency in the implementation of this research policy. IP and NoE will allow European Research to achieve the necessary critical mass to obtain significant and relevant results.

ANNEX 1

FP6 BUDGET (as decided by the Council, 3/6/2002)

	million €s
<b>1. Focussing and integrating Community research</b>	<b>13345</b>
1.1 Thematic priorities :	11285 <sup>1</sup>
1.1.1 Life sciences, genomics and biotechnology for health	2255 <sup>2</sup>
- Advanced genomics and its applications for health	1100
- Combating major diseases	1155
1.1.2 Information society technologies	3625 <sup>3</sup>
1.1.3 Nanotechnologies and nanosciences, knowledge-based multi-functional materials and new production processes and devices	1300
1.1.4 Aeronautics and space	1075
1.1.5 Food quality and safety	685
1.1.6 Sustainable development, global change and ecosystems	2120
- Sustainable energy systems	810
- Sustainable surface transport	610
- Global change and ecosystems	700
1.1.7 Citizens and governance in a knowledge-based society	225
1.2 Specific activities covering a wider field of research	1300
1.2.1 Supporting policies and anticipating s/t needs	555
1.2.2 Horizontal research activities involving SMEs	430
1.2.3 Specific measures in support of international co-operation	315 <sup>4</sup>
1.3 Non-nuclear activities of the Joint Research Centre	760
<b>2. Structuring the European Research Area</b>	<b>2605</b>
2.1 Research and innovation	290
2.2 Human resources and mobility	1580
2.3 Research infrastructures	655 <sup>5</sup>
2.4 Science and society	80
<b>3. Strengthening the foundations of the European Research Area</b>	<b>320</b>
3.1 Support for the co-ordination of activities	270
3.2 Support for the coherent development of R&I policies	50
<b>TOTAL</b>	<b>16270</b>
<b>1. Priority thematic areas of research</b>	<b>890</b>
1.1 Controlled thermonuclear fusion	750
1.2 Management of radioactive waste	90
1.3 Radiation protection	50
<b>2. Other activities in the field of nuclear technologies and safety</b>	<b>50</b>
<b>3. Nuclear activities of the Joint Research Centre (JRC)</b>	<b>290</b>
<b>TOTAL</b>	<b>1230</b>
<b>OVERALL TOTAL</b>	<b>17500</b>

Notes to Annex 1:

<sup>1</sup> of which at least 15% for SMEs

<sup>2</sup> including up to 400 € millions for cancer related research

<sup>3</sup> including up to 100 € millions for further development of Géant and GRID

<sup>4</sup> this amount of 315 € millions will fund specific measures in support of international co-operation, involving developing countries, Mediterranean countries including the Western Balkans, and Russia and the Newly Independent States (NIS). Another 285 € millions are earmarked to finance the participation of third country organisations in the "Thematic priorities" and in the "Specific activities covering a wider field of research", thus bringing the total amount devoted to international co-operation to 600 € millions. Additional resources will be available under Section 2.2 "Human resources and mobility" to fund research training for third country researchers in Europe

<sup>5</sup> including up to 200 € millions for further development of Géant and GRID



## Session 1: Promoting RES in Europe – The state-of-the-art

### EU strategy and instruments for promoting renewable energy sources

Karl Kellner, DG TREN, European Commission

**Keywords.** Renewables, energy policy, promotion strategies

#### Introduction

Within the European Union's energy policy renewable energy sources (RES) enjoy an important position. Nevertheless, the potential for their exploitation is underused in the EU at present. Within the Communities energy mix RES contribute to about 6% at present, see Fig. 1. As there can be seen from Table 1, electricity produced from renewable energy sources (RES-E) as share of total electricity generation amounts 14% for EU-15, although, huge differences occur between the Member States. Two countries, Austria and Sweden, generate more than a third of electricity from these sources. Fig. 2 illustrates the shares of the RE technologies on total primary energy production from RES for the Community: The largest share of RES comes from biomass, followed by hydro.

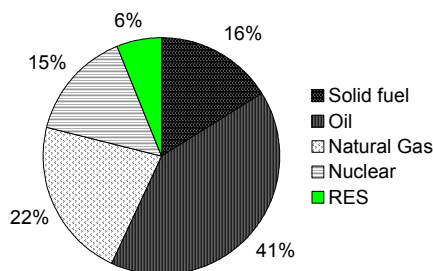


Fig. 1 EU energy mix in 1998

Source: EUROSTAT, 2001

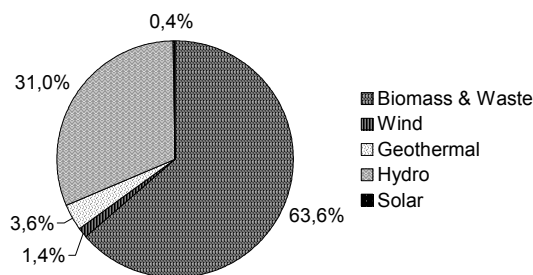


Fig. 2 Shares of the various RE technologies on total primary energy production from RES in 1999

Source: EUROSTAT, 2002

Table 1: RES contribution in 1999 for EU countries – (a) RES as share of total inland consumption and (b) RES-E as share of total electricity generation

Country	Total inland consumption [%]	Total electricity generation [%]
B	1.2	1.4
DE	2.6	5.4
DK	9.2	11.7
GR	5.5	10.0
E	5.2	12.8
FR	7.0	12.9
IRL	1.8	5.2
I	7.8	16.9
L	1.3	2.5
NL	2.1	3.4
A	23.4	68.1
P	11.1	19.8
FIN	22.2	26.3
S	26.7	46.2
UK	1.1	2.7
<b>EU-15</b>	<b>5.9</b>	<b>14.0</b>

Source: EUROSTAT, 2002

The Community recognises the need to promote renewable energy sources as a priority measure given that their exploitation contributes to environmental protection and sustainable development.

#### Energy Policy Targets for the Future

Clear Energy Policy Targets exist within the EU, all of them with particular relevance for the future development of RES. In more detail these targets are:

- Meeting Kyoto Objectives  
8% CO<sub>2</sub> reduction between 2008 - 2012 compared to 1990
- Doubling the Share of Renewable Energies  
From 6% to 12% of gross inland energy production 2010
- Improving Energy Efficiency  
Increase by 18% until 2010 compared to 1995
- Maintaining Security of Supply

#### How to achieve the Energy Targets? – The Tools

A comprehensive set of tools has been developed to achieve the given Energy Targets, on the EU level most important are:

- White Paper on Energy Policy
- White Paper on RES & Action Plan
- Green Paper on security of supply
- Directives
- Support programmes.

A short description of each of these tools will be given in the following.

### White Paper on Energy Policy

As the first tool, in January 1996 the *White Paper on Energy Policy* (European Commission, 1996) has been adopted. It defines the following objectives:

- Environmental protection
- Security of energy supply
- Industrial competitiveness

In general, RE technologies are consistent with these objectives. With respect to RES the following content of the White Paper is of interest:

- National and Community authorities are invited to adopt policies mobilizing significant resources for RES;
- Specific programmes or subsidies, least harmful to competition are foreseen;
- It is acknowledged, that RES constitute in the long term the main sustainable energy source, which calls for a strategy on RES development.

### White Paper on Renewable Energies & Action Plan

On 26<sup>th</sup> November 1997 the European Commission adopted the *White Paper for a Community Strategy and Action Plan - Energy for the future: Renewable Sources of Energy* (European Commission, 1997), which can be seen as one of the highlights of EU energy policy statements with respect to RES. In general, it sets out a Community strategy and an Action Plan to double the share of Renewable energy from 6 to 12 % in Gross Inland Production by 2010. Therefore, sub-targets are established in the various sectors and a tri-annual review procedure is instigated. In view of Community enlargement flexibility is preserved.

The *Action Plan* defines the accompanied measures, in more detail these are:

- Internal market measures
- Reinforce Community policies
- Support measures
- Campaign for take off.

### Green Paper on Security of Energy Supply

On 29<sup>th</sup> November 2000, the Commission adopted a *Green Paper on Security of Energy Supply* (European Commission, 2000), in order to launch a debate on the:

- geopolitical
- economic &
- environmental

stakes involved in securing the EU's energy supply. Therein basic facts about energy are described. In this context it is stated, that energy self sufficiency is impossible to achieve. Due to EU's energy-intensive economy with annual growth rates of 1 to 2 % in consumption, the existing gap between energy production

and consumption will grow rapidly in the future, see Fig. 3.

To improve the situation, in general two priorities of tomorrow occur:

- to curb the growth in demand
- to manage the dependence on supply.

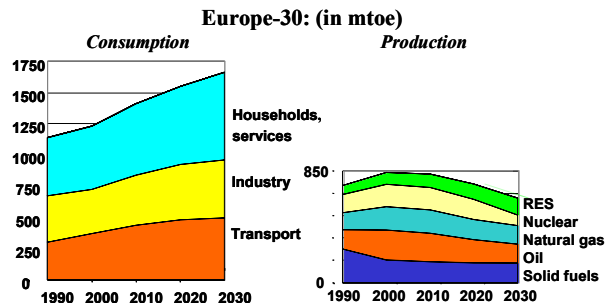


Fig. 3 Energy consumption vs. production – a scenario for EU's future

Curbing the growth in demand can be achieved by:

- Completing the internal market
- Review of energy taxation
- Energy saving and diversification plans
- Dissemination of new technologies.

Managing the supply dependence means:

- to foster the development of less polluting energy sources,
- to maintain access to resources &
- to ensure external supplies.

New and renewable forms of energy are the first options for action in relation to security of supply, the environment and rural populations. Due to their potential, waiting to be exploited, it is a political priority to accelerate their future development.

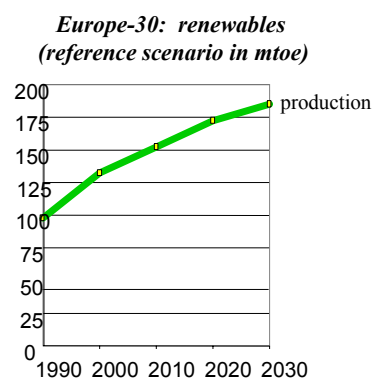


Fig. 4 Reference scenario for the development of RES

An impression of their possible development is given in Fig. 4, nevertheless, the various RE technologies have differing growth prospects. Their takeoff assumes that financial or tax incentives will be provided. To achieve the EU target of 12 % of energy consumption in 2010, equal to a doubling of their share compared to current level it is of crucial necessity to mobilise the support for RES. As an example RES could be financed by temporary levies on a share of the profits of

other conventional operators in the energy sector. The aid for RES is justified on the grounds that conventional energies do not contribute much towards the external cost they entail. Also, renewable do not have the same development facilities that other sectors had.

### Draft Directives

With respect to RES three draft directives are of importance at present:

- the Buildings Directive;
- the Directive on Combined Heat and Power (CHP) with the target of doubling the share of CHP from 9% (1994) to 18% (2010) and a special provision for renewable and
- the Directive on Liquid Biofuels with the mandate for a minimum use of biofuels and their detaxation.

In more detail, the Proposal for a Directive on the Energy Performance of Buildings shows the following objectives:

- Promoting the improvement of energy performance of buildings within the EU through cost-effective measures and
- Convergence of building standards towards those of Member States which already have ambitious levels.

To meet the objectives the following measures are proposed:

- Methodology for integrated buildings energy performance standards, including on-site renewables, and bioclimatic design;
- Application of these standards on new and existing buildings;
- Certification schemes for all buildings and
- Inspection & assessment of boilers/heating and cooling installations.

### Directive on the promotion of electricity from RES

On 27<sup>th</sup> September 2001, the *Directive on the promotion of electricity from RES* (European Union, 2001) has been adopted. It establishes national targets for electricity from renewable energy sources (RES-E), in more detail this means:

- Member States are obliged to establish national targets for future consumption of RES-E. The Directive gives in its Annex indications for these national targets.
- If the targets are met, consumption of electricity from renewable energy sources will rise from 14 % in 1997 to 22% by 2010;
- The Commission will monitor progress made by Member States towards achieving their national targets.

With respect to support systems the following parts are of importance:

- The Directive abstains from proposing a harmonised Community wide support system for RES-E;
- The Directive obliges the Commission to make if necessary a proposal for such a harmonised support system within 4 years, taking into account the experiences gained in Member States with the operation of the different national support systems.

Also considered are technical issues to promote RES-E – the Directive obliges Member States:

- to assure guaranteed access for RES-E;
- to issue guarantees of origin of RES-E;
- to assure that the calculation of costs for connecting new producers of RES-E should be transparent and non-discriminatory.

### Support programmes on Renewables

On a Community level three major support programmes on RES exist:

- The 5<sup>th</sup> Framework Programme (*ENERGIE*) with technological development as its main objective; Budget of 1.042 M€ (1998-2002);
- the *ALTENER II Programme* which fills the gap between demonstration & commercialization by providing non technological actions and studies aiming at overcoming non technical barriers; Budget of 74 M€ (1998-2002) and
- *Regional Policy & Structural Funds* with dedicated budget for deployment of RES in most promising EU Regions; Budget of 487 M€ (2000-2003).

### Cost comparison – Fossil vs. RES

As already mentioned conventional energies do not contribute much towards the external cost they entail. Of course, also RES cause external costs, but on a much lower level, e.g. see Fig. 5.

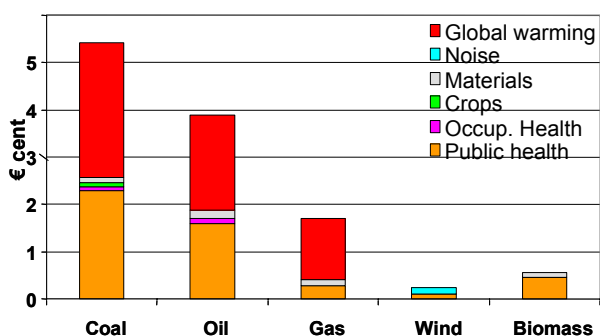


Fig. 5 Damage cost estimates for energy fuel cycles (UK specific results);  
Source: DG Research

In general, production costs are of crucial importance for the selection of a certain energy technology. A cost comparison of electricity generation costs – w/o external costs – for RES and fossil fuels is depicted in Fig. 6 (RES vs. Gas) and Fig. 7 (RES vs. Coal).

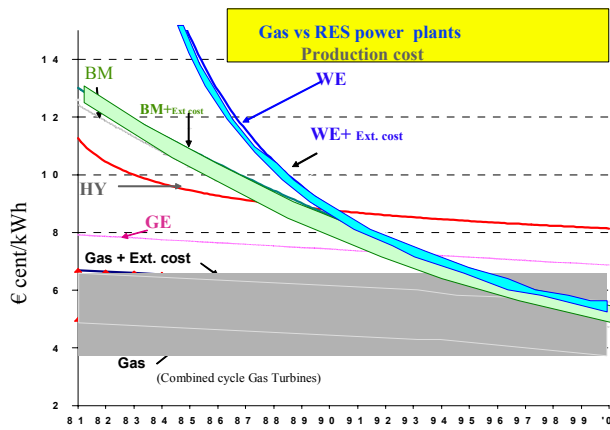


Fig. 6 Electricity generation costs of Gas vs. RES power plants (w/o external costs)

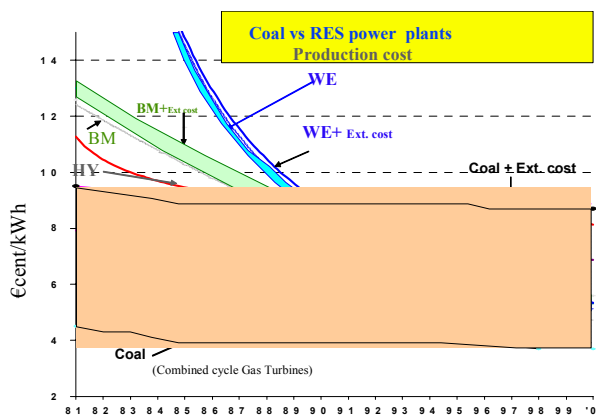


Fig. 7 Electricity generation costs of Coal vs. RES power plants (w/o external costs)

## Conclusions

The major conclusions are:

- Development of RES should become a political priority for the European Union;
- The EU strategy for RES will be successful provided – political impetus is seconded by adequate and timely legal and financial initiatives;
- To attain the ambitious targets set for 2010, apart from public financing, private investment in RES will be crucial in the coming years.

## References

- European Commission (1996): White Paper on Energy Policy, Com (95) 682 Final, European Commission, Brussels, January 1996.
- European Commission (1997): White Paper for a Community Strategy and Action Plan – Energy for the future: Renewable sources of energy, Com (97) 599, European Commission, Brussels, 26<sup>th</sup> November 1997.
- European Commission (2000): Green Paper of Security of Energy Supply, European Commission, Brussels, 2000.
- European Union (2001): Directive on the promotion of electricity produced from renewable energy sources in the internal market, Com (2001) 497, European Union, Brussels, 27<sup>th</sup> September 2001.

## Survey on and review of promotion strategies for RES in Europe

Reinhard Haas, Energy Economics Group, Vienna University of Technology, Austria.

**Keywords.** Renewables, promotion strategies, success criteria

**Abstract.** The promotion of Renewable Energy Sources (RES) has a high priority in the energy policy strategies of many countries world-wide. In this paper a survey on the potentials and costs of RES in EU countries is given. Moreover, a survey on international promotion strategies is presented and some examples for successful dissemination strategies are depicted. Finally, the most important criteria for successful deployment strategies are described. The major conclusion for further strategies is: strategies have to address both, enhancements in customers WTP as well as cost reductions, simultaneously. Only then the demand for electricity from renewables can be increased significantly!

## Introduction

The promotion of Renewable Energy Sources (RES) has a high priority in the energy policy strategies of many countries world-wide. In Europe the *White Paper on Renewable Sources of Energy* and the *Directive on the promotion of electricity from RES*, published by the European Commission, set challenging goals to double the share of renewables in the energy mix of EU countries.

The great importance of electricity from RES is due to the expected associated benefits, namely:

- Reduction of greenhouse gas emissions;
- Increases in local employment and income;
- Avoided risks of disruption in fossil fuel supply and association price instability
- Provision of infrastructure and economic flexibility by modular, dispersed and smaller scale technologies;
- Enhanced local tax revenues;

## Historical milestones

Currently, a wide range of strategies exist in different countries to increase the market penetration of RES. Historically, the first dissemination strategies for electricity from RES were rebate programmes, whereby purchasers of renewable energy generating plants could claim back (i.e. be rebated for) part of the costs as a government grant. The most influential rebate programmes were (a) the wind promotion programme in Denmark, and (b) the German “1000 Roofs Programme” for promoting photovoltaic (PV) power, and the tendering programme within the Non-Fossil Fuel Obligation (NFFO) in UK. Moreover, rebates played an important role in increasing market penetration of wind energy in Denmark and Sweden.

A less successful programme was the promotion programme for solar thermal collectors launched in 1978 in the USA by president Jimmy Carter. The major problem was that no technical standards accompa-



nied this programme and as a result many manufacturers of solar thermal systems were “fly by night”.

In the early 1980s financial incentives, in the form of loans or reduced taxes, were also popular. The most successful examples were in Germany and Denmark, where, for instance, it was possible to obtain preferential real estate loans for wind turbines.

In the mid-1990s, in various European countries, promotional programmes based on regulated tariff rates for the purchase of electricity from specified renewable sources became more common and were enhanced. The most important models in this context were enhanced feed-in tariffs and rate-based incentives in Denmark, Spain and Germany.

An increasingly popular mechanism is Green Electricity Pricing. Within these programmes, supply companies and utilities offer electricity from renewable sources at special tariffs. Generally, these are at an enhanced price to cover increased generation costs. By giving customers the opportunity to choose the “brand” of electricity according to their willingness to pay, no public funds are necessary to increase the use of renewables. Table 1 summarises the most important historical steps for such promotional strategies.

Table 1 Milestones in the promotion of renewables in different countries

Year	Strategy / Programme /country
1978-1985	Rebates for wind in Denmark
1978-???	Tax incentives for solar thermal collectors in the USA
1981-present	Net metering for RES-E in various states in the USA
1989-1998	Do-it-yourself groups for solar thermal collectors in Austria
1989-1993	1000-Dächer-Programm
1990-1999	Bidding/Tendering for RES-E in UK (NFFO)
1990-present	Feed-in tariffs for RES-E in Germany
1991-present	“Bra Miljöval” – Label for Green electricity in Sweden
1992-1999	Tax relief for wind energy in Denmark
1994-present	“Residential PV promotion programme” in Japan (Rebates)
1996-present	“Solarstrombörse” for PV in various cities in Switzerland
1997-present	Various brands of labelled Green Electricity (TÜV, Grüner Stromlabel e.V., Öko-Institut) in various countries
1999-present	Soft loans for PV in the German “100,000 Dächer-Programm”
1999-2000	Voluntary Green certificate trading system in The Netherlands
1999 -200x	California's emerging renewables buydown rebate programme
1999-present	Feed-in tariffs for RES-E due to the Royal Decree in Spain
2000-present	Feed-in tariffs for RES-E due to the “Renewable energies law” in Germany

### Potentials and costs

Now we look at the possible contribution of RES to energy supply. First of all it is important, to figure out whether there is a substantial potential which makes it worth to pursue this idea further. Second the corresponding costs have to be identified by means of deriv-

ing static cost curves. Third, it is of relevance to identify strategies to remove the barriers.

Fig. 1 depicts how potentials, barriers and strategies are linked in principle. The electricity generated is shown depending on the time. We start with the historical development of a renewable energy source in a certain country and identify different potentials. Various barriers I, II, III ... exist which impede the practical achievement of the potentials. If no policy strategies are implemented, the lower broken line will be achieved the so-called business-as-usual scenario. If an ambitious policy launches the proper strategies the upper broken line will be achieved.

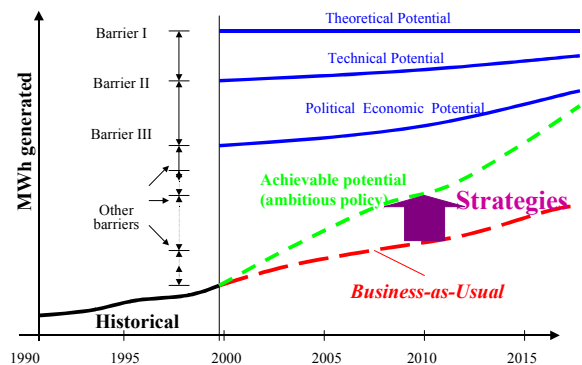


Fig. 1. Interaction between potentials, barriers and strategies

The Figures 2 and 3 show that there is a substantial potential for generating electricity from various RES-sources as well as for producing heat from biomass. The by far largest potential exist for on-shore and off-shore wind energy. Almost 6000 TWh electricity could be generated every year in EU countries by wind turbines (Fig. 2). For a comparison: The total electricity consumption in EU countries is around 2500 TWh in 2000.

### POTENTIAL IN EU-15 - ELECTRICITY

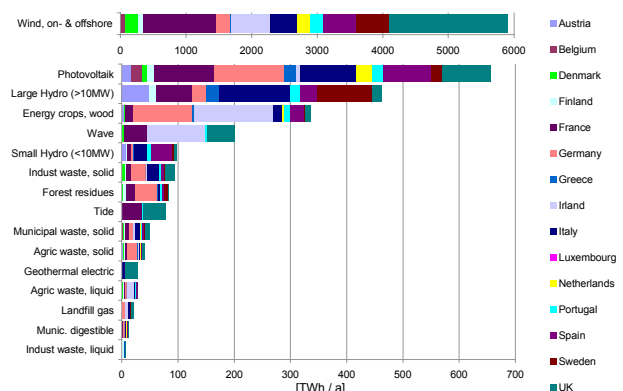


Fig. 2. Potential for electricity generation from RES

The total primary energy potential for biomass is about 8280 PJ (2300 TWh/year) based on the year 2010. Of course this potential could be converted either in heat only or in electricity & heat or in bio fuels (see Fig. 3).

## BIOMASS POTENTIAL IN EU-15

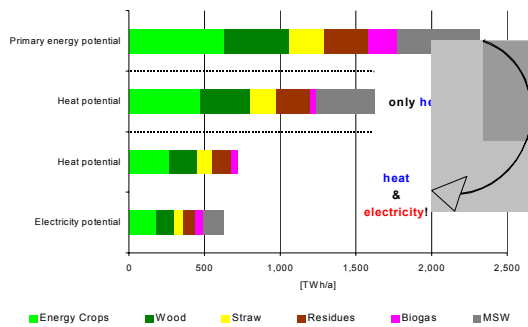


Fig 3. Primary energy potential of biomass and potential for heat and electricity generation

A static cost curve provides for any specific point-of-time a relationship between (categories of) technical available potentials (of e.g. wind energy, hydro power, biogas...) and the corresponding (full) costs of utilisation of this potential at this point-of-time (Note, no learning effects are included in static cost curves!). Fig 4 depicts an example for a static cost curve where the investment costs (IC) depend on quantity only.

## EXAMPLE: STATIC COST CURVE WIND ON-SHORE EU15

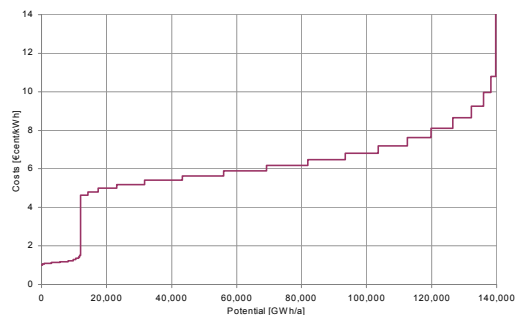


Fig. 4. Example for a static cost curve (Wind on-shore in the EU countries)

## EXAMPLE: HISTORICAL DEVELOPMENT COSTS WIND

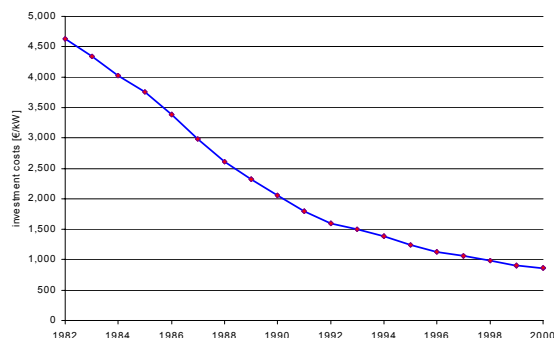


Fig. 5 Development of the investment costs of wind turbines in Europe

The development of the costs for wind turbines in Germany is shown in Fig. 6. It is of interest that prices dropped from around 4500 €/kW in 1982 to 2000 €/kW in 1990 and further to below 1000 € in 2000.

The high capital investment costs of RES have been a major impediment to broader market penetration. These costs are shown in Fig. 4 for various types of RES from 1980 to 2000. All cost curves of the new technologies have decreased over time. The current range of costs in Europe is depicted in Fig. 5.

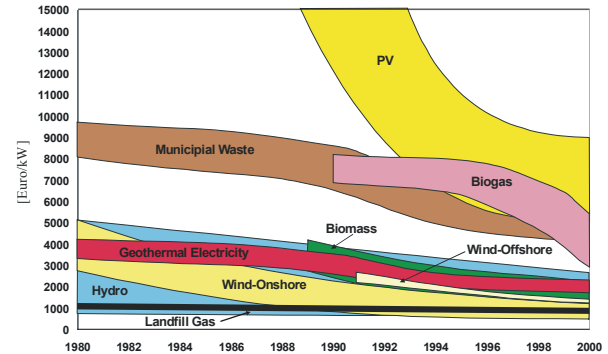


Fig. 6. Development of investment costs of RES for electricity generation in EU-15 from 1980 – 2000

## COSTS ELECTRICITY

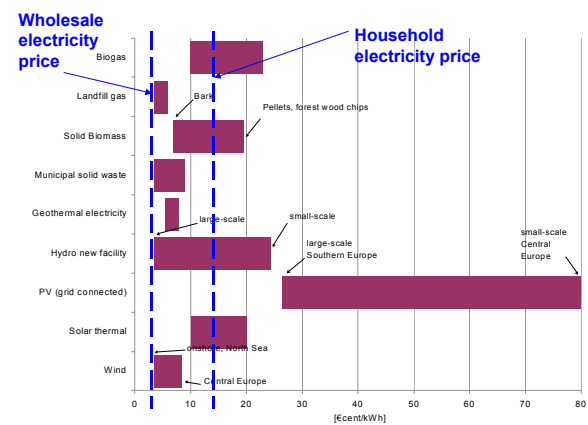


Fig. 7. Costs of electricity generation from RES in Europe in 2002

## COSTS HEAT

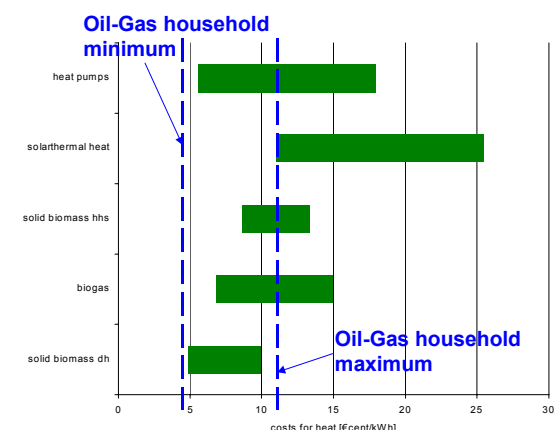



Fig. 8. Costs of heat production from RES in Europe in 2002

## Deploying RES: How?

To increase the market penetration of RES strategies have been implemented in various European countries in recent years. Table 2 provides a classification of the existing strategies for encouraging the use of RES. The terminology is explained in detail in Haas 2000. Note, that with respect to these strategies it is of high relevance to differ between RES generating electricity and RES producing heat!

Table 2 Fundamental types of strategies

				HEAT		ELECTRICITY	FUEL
				autonomous	district heat	grid connected	
	Regulatory capacity-driven	Investment focused	Bidding, Quota	(X)	X	X	
		Generation based	Quotas, TGCs		X	X	X
	Regulatory price-driven	Investment focused	Rebates, Investment based tax incentives	X	X	X	X
		Generation based	FiTs, Rate-based incentives, Generation based tax incentives		X	X	
	Voluntary	Investment focused	Do-it-yourself groups, Investment coop's, Purchase coop's, Shareholder coop's, Contribution programmes	X	X	X	X
		Generation based	Green tariffs, Solar stock exchange, TGCs		X	X	

In principle we differ between direct and indirect types of strategies. Direct strategies are regulatory capacity-driven strategies, regulatory price-driven and voluntary price-driven strategies.

Regarding the variety of strategies it must be stated that much more are available for electricity and grid connected heat than for individual heating/hot water system and fuels for transport. An important issue in this context is furthermore the difference in investment-focused and generation-based approaches. Most important is that generation based approaches automatically provide the incentive for a technical optimal operation of the system.

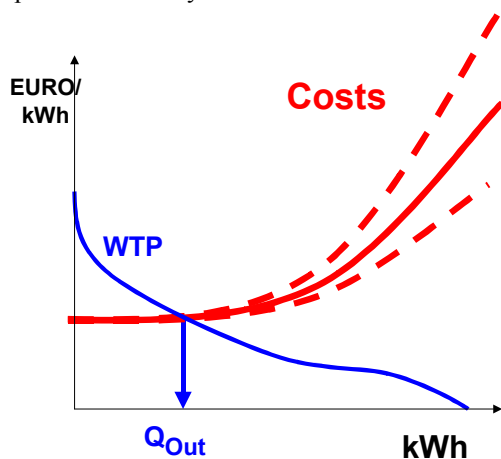


Fig. 9. Voluntary approach: focus on customers WTP

Voluntary generation-based Green Pricing models by utilities as Green tariffs and Solar stock exchanges are based on a high consumers' willingness to pay for "green electricity" and trust in the seriousness of the utility which offers it. Hence, they depend very strongly on the credibility of the organisation that offers it. Effective green pricing programmes have to exhaust electricity consumers' willingness to pay for "green electricity" as far as possible. In general green tariff programmes need a lot of public relations work from the utility to make them work (See e.g. the RWE programme in Germany or the ewz "Solarstrombörse" in Switzerland). Most important is that they are accompanied by a credible green label.

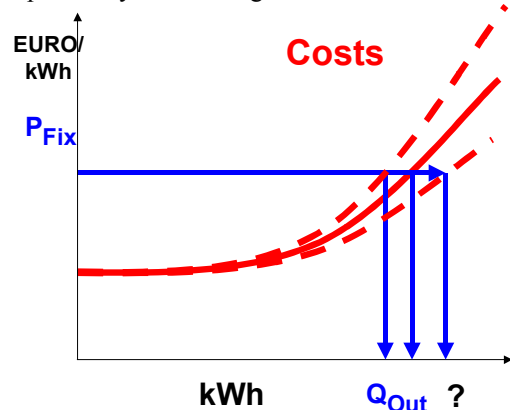


Fig. 10. Regulatory price driven strategies: fixed price for RES-E

A promotion strategy, which has attracted attention since the late 1980s especially in Denmark and Germany and, in the 1990s, in Spain are Feed-in tariffs (FITs), see Fig. 10. A feed-in tariff is the price per unit of electricity that a utility or supplier has to pay for renewable electricity from private generators (also called “producers”). Thus, a federal (or provincial) government regulates the tariff rate. Such schemes may limit the offer to a certain total capacity for the whole programme. Currently the highest “feed-in” prices in Europe are in force in Germany, Italy and Spain. Note that any intending producer is guaranteed the feed-in tariff for each unit of electricity fed into the grid if his form of generation meets the stated criteria; no bidding process or tendering is involved. This ‘open’ procedure without tendering contrasts with “obligation” programmes, e.g. the NFFO in the UK, where increased tariffs are only available to the selected ‘winners’ after competitive tendering. The feed-in tariffs attract much capacity, since the revenues from the plant are guaranteed, as long as the unit price is set on a high level (e.g. the substantial growth of wind power in Denmark, Germany and Spain in the past years).

The major advantages of regulatory price driven strategies are:

- They are effective in the sense that they trigger substantial installations of new RES;
- They ensure technically efficient operation of the plant;
- The transaction costs and the administration costs are low;

- FITs provide an assured aspect of business plans for new investment;
- They allow small co-operative groups and companies to participate.

The major points of criticism with respect to feed-in tariffs are:

- They provide subsidies;
- They do not ensure that the economically most efficient plant is installed;
- They do not encourage competition between generators.

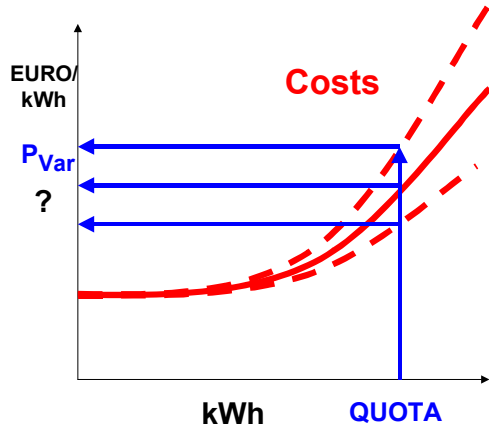


Fig. 11. Regulatory capacity driven strategies: fixed quota for RES-E and high penalty

A type of strategy which has attracted a lot of attention at least in theoretical discussions are quota-based Tradable Green Certificate programmes. In principle they should work as follows, see Fig. 11: The generators (producers), wholesalers, retailer or consumers (depending who is obligated in the electricity supply chain) are obligated to supply / consume a certain percentage of electricity from renewable energy sources. At the date of settlement, they have to submit the required number of certificates to demonstrate compliance. Those obligated obtain certificates in three ways:

- They can own a renewable energy generation plant. Each defined amount of energy (e.g. 10,000 kWh in the Dutch system) produced by these facilities would represent one certificate;
- They can purchase electricity and associated certificates from another renewable energy generator.
- They can purchase certificates without purchasing the actual power from a generator or broker, i.e. purchasing certificates that have been traded separated from the power itself.

Due to competition on the supply side, this system of tradable certificates should in theory, under the assumption of perfect market conditions (perfect price signal), lead to minimal generation costs from renewable energy sources. Of course, this happens only if there is a surplus of renewables generation above the demand for certificates. Regarding TGC it has to be stated that so far to less experience is available to provide an in-depth evaluation. The major arguments in favour of TGC are:

- High economic efficiency;
- A market for best-practice in the environment is created;
- No market distortion due to fixed subsidies;
- The market determines the magnitude of the subsidy.

Possible setbacks are:

- Uncertainty about actual investment;
- Unpredictable (volatile) revenues;
- High administration and transaction costs<sup>14</sup>.

Anyway, it is important to state, that in all three cases mentioned above finally the public pays! In voluntary programmes some people pay more, some people pay less. If cost-driven strategies are implemented these subsidies (rebates, FITs) are paid by the electricity users and the same applies for capacity driven strategies. The major goal for policy must be to find the strategies which minimizes public costs!

### Examples/Success stories

In the following some successful examples for programmes implemented in the past or currently are described in brief.

#### *Promotion of solar thermal systems in Austria*

Since the early 1990s in Austria the market penetration of solar thermal systems for hot water preparation increased tremendously mainly due to so-called do-it-yourself groups, see Fig. 10 Yet, in recent years two effects emerged: the number of systems installed per year decreased since 1997 and the market share of the do-it-yourself groups dropped substantially from 51% in 1992 to 8% in 1998!

### AUSTRIA: SOLAR THERMAL SYSTEMS

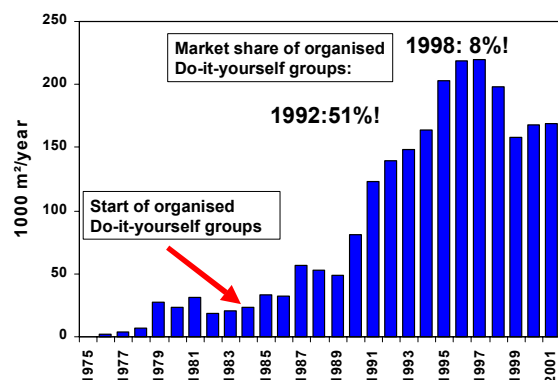


Fig. 12. Dissemination of Solar thermal systems in Austria

Sources: Faninger 1999, Faninger 2001, Weiss 1996

<sup>14</sup> Experience from the Netherlands shows that these costs are in the order of 2% of the price paid for a certificate. When the volume traded will increase, this rate is likely to decrease, because a large portion of the costs is associated with fixed costs and start-up of the system.



### Biomass district heating systems in Austria

The Austrian case of Biomass District Heating Systems (BMDH) is one of the few examples within Europe where biomass has successfully been introduced into the energy market (see Danielsen et al 1995).

The first BMDH plant was established by a sawmill operator in the village of Feldbach in 1979. Starting in the early eighties and continuing to the present interest in BMDH has been rising rather continuously. Figure 13 shows the increase in the number of yearly constructed BMDH plants between 1980 and 2001. The rate of growth has been on an average 25% since 1987; before, growth rates showed large fluctuations due to the small number of plants. During the first phase until 1984, sawmills owners were the predominant operators of BMDH plants. They were succeeded by municipalities and farmers co-operatives. In the late 1980s electric utilities emerged as new actors. In some cases, joint ventures with farmers co-operatives were initiated. Currently, (2002) around 700 systems exist. The highest density exists in the province of Styria, see Fig. 14. Villages with BMDH plants usually have between 500 and 3000 inhabitants and are of a predominantly rural character. Accordingly, the size of BMDH plants varies between a few hundred kW and up to 8 MW, with corresponding grids between 100 meters and 21 km. Almost two-thirds of all plants have a power of less than 1500 kW. The average size of all BMDH plants in Austria is currently around 1.25 MW

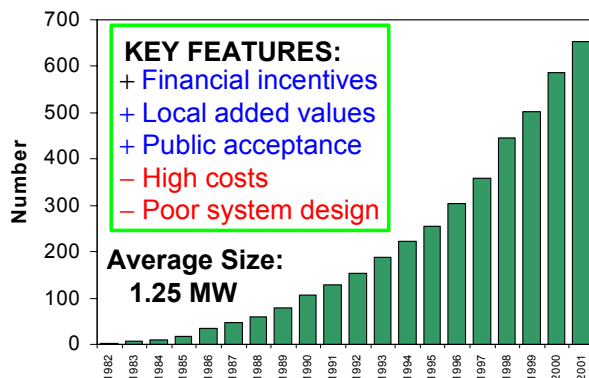


Fig. 13. Dissemination of biomass district heating systems in Austria

The key features that contributed to this dissemination effect are:

- Considerable financial incentives in the range of 30-50% were provided;
- Local values, like increase in employment and revenues for farmers and the municipality were added.

Yet, it has also to be mentioned that there are some critical aspects with respect to the spread of BMDH:

- The cost of the systems as well as of the heat generated are considered to be very high;
- The design of most systems is poor, Tits, the boilers as well as the pipe networks are oversized in many cases.

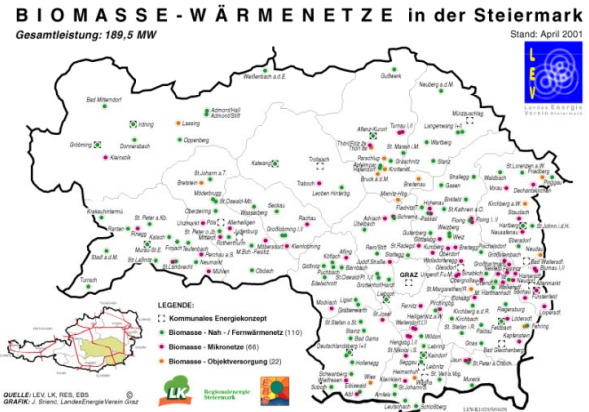


Fig 14. Dissemination of biomass district heating systems in Styria in Austria

### Wind energy in Denmark

Incentives for wind energy in Denmark varied over time. In principle the Danish government has not spent much money directly to support wind power but has provided intelligent indirect and non-economic support (Helby 1996).

First in the 1980s environmental restrictions were relaxed. While it was quite difficult to get a permission to build any kind of structure in the Danish countryside, liberal rules were created for wind mills (Helby 1997). Note, that in recent years these rules have been made more restrictive.

Second, the electric utilities were forced by law to connect private wind mills to the grid and to pay a fair price for the power.

Third, income tax rules have favoured family investment in wind power. As long as the number of shares owned by a family corresponded to the families own electricity consumption there has been no tax on the shares in Denmark. (Helby, 1997)

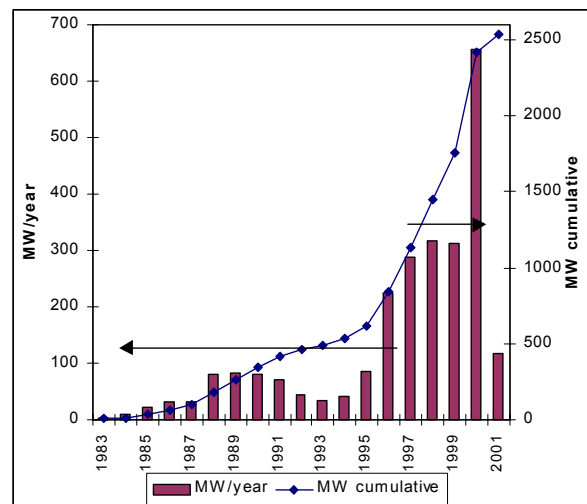


Fig. 15. Development of installed Wind capacity in Denmark

In general, the incentives depended on ownership, which can be divided into three categories: wind energy co-operatives, private ownership, and utility ownership. For co-operatives and private owners, incentives include the following: 1: guaranteed power pur-

chase contracts with utilities in which utilities pay generators 85 per cent of the local retail price of electricity; 2: refund of the energy tax; and 3: refund of the CO<sub>2</sub> tax.

Note that only in the early days of wind power subsidies were available. These guaranteed capital grants of 30 per cent for wind energy were gradually reduced until their removal in 1989.

Furthermore, individual persons who participate in wind energy co-operatives can own up to 20,000 kWh/year-worth of shares in the co-operatives, of which the first DKK 3000/yr of income is tax-free (and the remainder taxed at a 60 per cent rate). To the extent that the wind power purchase contracts increase the cost of electricity, these costs are passed on to utility ratepayers. Lastly, any grid reinforcement which may be required as a result of non-utility wind power installations are paid for by the utilities.

Utility-owned wind power projects do not benefit from preferential tax treatment or from any refund of the energy tax, though utilities can obtain refunds of the CO<sub>2</sub> tax. Less incentive therefore exists for utilities to build wind projects than for co-operatives and private owners. Nevertheless, utilities are committed to building more wind power as part of an agreement with the Danish government. In 1995, approximately 30 per cent of total installed wind energy capacity was utility-. Total installed wind energy capacity in Denmark in late 2000 was approximately 2400 MW. It can also be seen from Fig. 15 that due to a change in promotion policies the numbers in yearly installations dropped from 650 MW in 2000 to 117 MW in 2001! (see also Morthorst, this issue).

#### Wind energy in Europe

The feed-in tariffs introduced so far in Denmark (until 2000), Germany and Spain led to the installed cumulative capacities for wind, as depicted in Fig. 16. The high growth rates of 45 to 50% in some years are especially impressive.

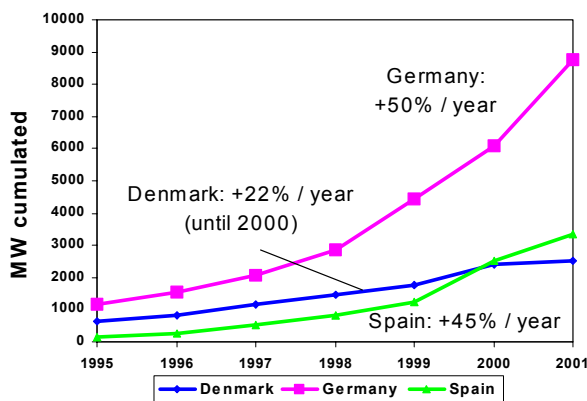


Fig. 16. Development of cumulated installed wind energy capacity in the most successful European countries 1995-2001

Fig. 17 compares the dissemination effectiveness of bidding vs feed-in tariffs for wind energy in Europe. The higher dissemination effectiveness of the feed-in tariff is evident.

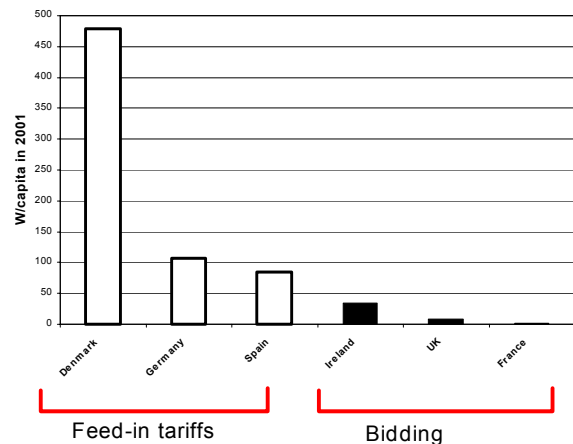


Fig. 17. The success of feed-in tariffs and bidding strategies for promoting Wind energy in selected European countries

#### PV in Switzerland

The most successful country with respect to disseminating PV substantially without providing generous subsidies is Switzerland. An idea of providing financial incentives for the construction of PV systems which has especially attracted attention is the so-called “Solar stock exchange”. The idea is that electricity is generated by private-owned PV systems and fed into the public grid. Other customers may buy this electricity and pay rates corresponding to the PV production costs. On the supply-side only the most cost-effective projects are selected by a bidding process.

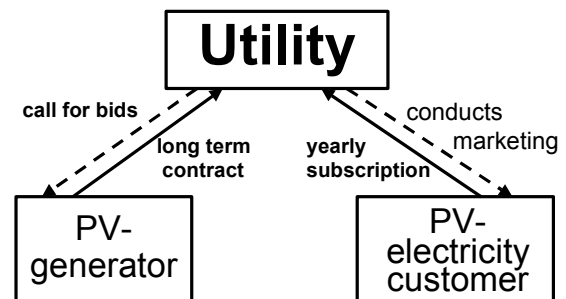


Fig. 18. The principle of the “Solarstrombörse” applied by various utilities in Switzerland

The utility acts as a “power exchange”. That is to say it organises the balance between supply and demand, see Fig. 18. Usually, the utility bears the administration costs but has no other expenses.

The advantages of this strategy are:

- Customers WTP is fully exhausted;
- Efficient operation is ensured
- Private “green” PV owners ensure that only the best examples for PV will be constructed;
- Kind of a “Green label” with high credit maybe associated with this type of strategy;

This idea has firstly been developed by ewz in Zurich in Switzerland and has in the meantime attracted attention also in other cities. At the end of 2001 around 2.2 MW has been installed, see Fig. 19.

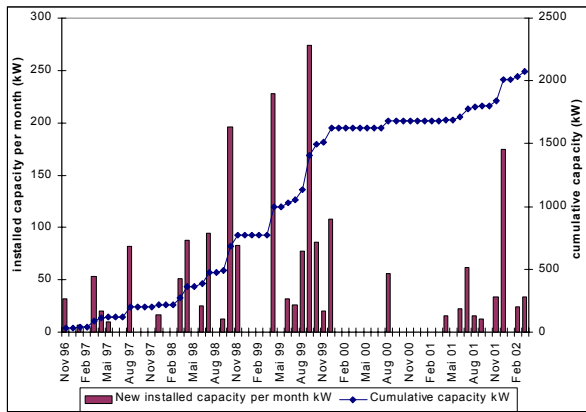


Fig. 19. PV installments within the “Solarstrombörse” programme of the EWZ in Zuerich (Switzerland)

### Success criteria

There is a wide range of possibilities to increase the dissemination of RES and many examples for successful programmes exist. The most important general criteria for successful deployment strategies are:

- Ensure continuity over a certain time frame
- Ensure high credibility of the institution/actor who launches a strategy
- Ensure social acceptance!
- Trigger and enhance competition!
- Add monetary or other values

In detail there are eight key factors for successful dissemination strategies of RES-E systems, see Fig. 20:

1. Provide a minimum of a financial incentive that allows to fully exhaust customers WTP!
2. Improve the market: Ensure that the competitiveness and the transparency of the market for renewable energy technology as well as of the market for electricity (e.g. by means of a power content label) is enhanced! Moreover, ensure continuity of the strategy over time and sustainable growth of the industry!
3. Strive for a guaranteed technical performance, an increase of standardisation and efficiency!
4. Try to make the programme a social event and to address the public as well as the mass-media!
5. Strive for setting the correct regulatory conditions from societies point-of-view! Remove barriers for access to the grid and introduce environmental pricing!
6. Minimise the costs for the public! Strive for low administration and transaction costs and minimize monetary financial support to reach a certain amount of RES-E capacity!
7. Provide comprehensive detailed and targeted information for the potential programme participants!
8. Conduct marketing! What are the potential customers and what are their needs?

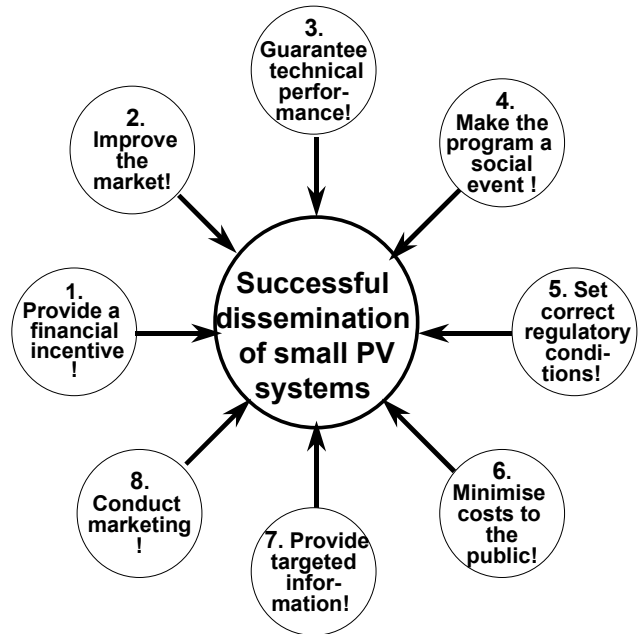


Fig. 20. Key factors for successful dissemination strategies of RES

### Conclusions

Currently world-wide a large variety of success stories for the dissemination of RES is available. The major conclusions derived from this analysis are:

Of principal relevance is to take into account the dynamic development of two major features:

- the costs to customers (monetary and “hidden” transaction costs) and
- the WTP of private or commercial investors;

Hence, most important is that measures contribute to both of these features: to increase customer’s WTP on the one hand and to reduce the (monetary and transaction) costs for customers on the other hand. Only so the actual demand can be increased substantially. Fig. 21 depicts these effects in a traditional supply and demand diagram.

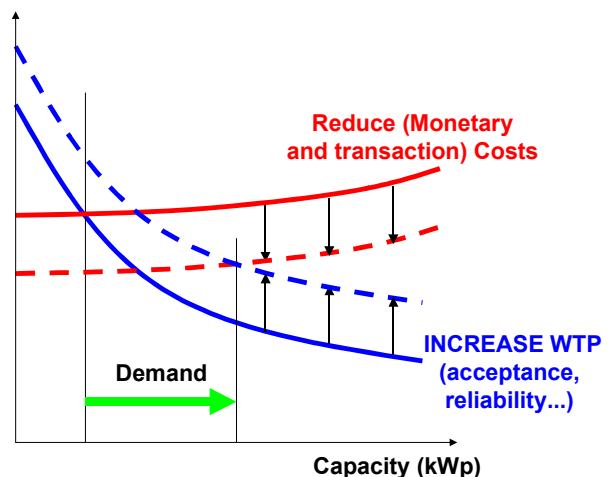


Fig. 21. How enhancements in customers WTP and decreases in costs influence the demand for RES

Other important conclusions are:

- For politicians most important is to set the correct regulatory incentive;
- Accompanying social acceptance activities are of high relevance for any deployment strategies!
- Continuity over time is a basic condition for every type of strategy!
- Increasing the efficiency of energy use is an important complementary objective!
- and finally it became evident that to reach higher market shares is mainly a policy issue!

Green Certificates for the deployment of renewable electricity", ECN.

Weiss Werner, The Austrian Solar Thermal Market. Arbeitsgemeinschaft ERNEUERBARE ENERGIE – AEE, IEA-SHC Task 26, Gleisdorf, 1998

## References

- Danielsen Oluf, Hackstock Roger, Koukios Emanuel, Rakos Christian: "Pathways from Small Scale Experiments to Sustainable Regional development", Final report for the EC, 1995.
- Faninger Gerhard, „Die Marktentwicklung der Solar- und Wärmepumpentechnik in Österreich: Berichtsjahr 1998“. im Auftrag des bm:vv und in Zusammenarbeit mit der Arbeitsgemeinschaft Umweltenergie in der Wirtschaftskammer Österreich, 1999
- Faninger Gerhard, „Der Solarmarkt in Österreich 2001, in Zusammenarbeit mit dem Bundesverband SOLAR Österreich in der Wirtschaftskammer Österreich“, April 2002
- Haas Reinhard, "Market Deployment Strategies for PV in the built environment", Report of Task 7 of the PVPS implementing agreement of the IEA, 2002
- Haas R., Faber Th., Green J., Gual M., Huber C., Resch G., Twidell J., "Review report on promotion strategies for electricity from renewable energy sources, activities in EU countries. Joint report by the cluster "Green electricity" within the 5th framework programme of the European Commission", September 2000
- Haas R., T. Faber, J. Green, M. Gual, C. Huber, G. Resch, J. Twidell (2001): "Promotion Strategies for Electricity from Renewable Energy Sources – Activities in EU Countries", Review Report – Green Electricity Cluster, DGTREN.
- Helby, P. (1996) "Rationality of the Subsidy regime for Wind power in Sweden and Denmark" EWEA Special Topic conference, 5.-7. 9. 1995.
- Helby, P. (1997) "Wind power in Denmark". in: Jürgen Salay (ed.): Energy. From fossil fuels to sustainable Energy Resources. Uppsala: The Baltic University programme, Uppsala University 1997.
- Huber C., H. Cleijne, T. Faber, J. Green, R. Haas, G. Resch (2001a): "Formal framework of the model ElGreen" – Internal report of the project "Organising a Joint European Green Electricity Market (ElGreen)", Energy Economics Group (EEG), Vienna University of Technology, Austria.
- Huber C., T. Erge, T. Faber, J. Green, R. Haas, G. Resch, W. Ruijgrok, J. Twidell (2001b): "Final Report" – Public report of the project "Organising a Joint European Green Electricity Market (ElGreen)", Energy Economics Group (EEG), Vienna University of Technology, Austria.
- Morthorst P.E. (2000): "The development of a green certificate market", System Analysis Department, Risø National Laboratory, Energy Policy 28.
- Petrovic L. (2000): "The greener option", Power Engineering International.
- Resch G., M. Berger, L. Kranzl (2001): "Database for the Model ElGreen" – Internal report of the project "Organising a Joint European Green Electricity Market (ElGreen)", Energy Economics Group (EEG), Vienna University of Technology, Austria.
- Schaeffer G.J., M.G. Boots, T. Anderson, C. Mitchell, C. Timpe, M. Cames (1999): "The Implications of tradable

## Transaction Cost Economics of Regulations to foster Renewable Energy Sources in the Electricity Sector

*Ole Langniss, Department of Environmental and Energy Systems Studies, Lunds Universitet<sup>15</sup>*

**Keywords:** Transaction Cost Economics, Regulation, Renewable Energy, Price Standard, Quantity Standard

**Abstract:** Renewable portfolio standards (RPS) and minimum price standards are two systems to foster the market dissemination of renewable energies in the electricity sector. Transaction Cost Economics brings forward that the contractual relations in real structures have to be investigated to judge on the efficiency of governance structures. This paper seeks to do so by comparing governance structures created by the Texan RPS and the German EEG as an example for a successful minimum price standard. Analysis suggests that differences in static efficiency between both regulations are not as big as economic theory would suggest. The need to safeguard long-term investments establishes long-term contracts as the prevailing form of governance in the Texan RPS, thus limiting competition. On the other hand, the German EEG provides a large range of freedom to the power generators giving them strong incentives to optimise both the investment and the operation of a power plant.

### Introduction

Renewable energy sources (RES) are seen by many as an indispensable part of a sustainable energy supply system (e.g. Nakicenovic et al. 2000; Nitsch et al. 2000). Yet, utilisation of RES is often not economically competitive under current conditions. Therefore, different public regulations have been developed to support RES in the electricity sector. Most prominent are minimum price standards (MPS) (such as established in France, Germany, Spain and until recently Denmark) and renewable portfolio standards (RPS) as they have been established only recently for example in Italy, Austria, the UK, Australia and some states of the US. Countries with MPS have seen by far the largest growth of RES in particular in regard to wind power even though this development cannot be solely attributed to the specific support regulation but depends also on e.g. a fair access to the electricity grid and transparent and rationale building permissions. In comparison with MPS, RPS are often assumed to introduce more competition on RES markets thus allowing to reach public targets for the implementation of RES at lower costs (e.g. Berry, Jaccard 2001). However, the quasi-rents from long-term investments typical for RES power plants need to be safeguarded against potential appropriation. Thus, long-term contracts rather than spot-markets will be the prevailing form of governance eroding some of the benefits of competition. On the other hand, the governance structure created by minimum price standards might not be so anti-competitive in practise as neo-classical eco-

nomic theory would suggest. Thus, static efficiency of both support regulation might not differ so much in reality.

This paper seeks to analyse realised governance structures resulting from a minimum price standard and an RPS by comparing the provisions in the Texan RPS with the provisions under the German Renewable Energy Act (EEG). We will examine the means which have been applied by RES generators, obliged parties and the state to reduce the risks for hold-ups in reality. Comparative advantages and short-comings of the different regulations are described. In our analysis, we rely heavily on tools provided by Transaction Cost Economics (TCE).

### The Theoretical Framework of Transaction Cost Economics

The choice of an appropriate organisation of economic acting, a governance structure is in the central focus of TCE. It starts from the observation that the human capacity to process information is limited. People intend to act rational but are bounded by their own limits of thinking. Thus economic actors are deciding with only imperfect information (Richter, Furobotn 1999,510) and bounded rationality (Simon 1957,198). Having said this, the organisation of transactions is inevitable causing costs, so called transaction costs. Moreover, economic actors are guided by opportunism, a rather euphemistic term for dishonesty, fraud and malice. Investments specific to a certain transaction open the door for opportunistic behaviour: Specific investments are thereby characterised by quasi-rents which can be derived from this investment in comparison to its next profitable application. Since these quasi-rents are specific to a certain transaction the quasi-rent is on risk for hold-ups by the transaction partner. By threatening the asset owner with breaking of the relation he will be able to appropriate at least a part of the quasi-rents. Anticipating this danger, the asset owner will invest in more generic assets with lower quasi-rents but possibly also lower efficiency. Alternatively, an appropriate governance structure which safeguards the quasi-rents of the specific investments against hold-ups may be established (Williamson 1987). In so doing, efficiency gains due to the specific investment can be realised which is potentially profitable for both transaction partners. The extent of specific investments is a main determinant for the choice of an efficient governance. The higher the specificity the more will the governance be characterised by patterns of hierarchies with cooperative and intentional adaptations to changes in the environment, with accounting and auditing as administrative controls, but also with lower incentive intensity. In contrast, low specificity of investments allows a governance by markets benefiting from the high powered incentives to optimise which are provided by markets. This makes also clear, that the choice of an efficient governance is not solely that between markets or hierarchies but that there exist a number of hybrid governance structures.

Power plants are typical examples of specific investments. Higher efficiency both in a technical and

<sup>15</sup> Gerdagatan 13, SE-22362 Lund, Sweden, Phone +46 46 2229871, Fax +46 46 2228644, ole.langniss@miljo.lth.se

economic sense comes usually with higher investment costs for a given generation capacity and a given fuel source. A power generator has usually to rely on a certain transaction partner at least on the short-term, making him vulnerable for hold-ups. To achieve a high efficiency, investments in power plants were safeguarded by comprehensive public regulation in the past. With liberalised markets an alternative governance in form of long-term power purchase agreements is established to allow similar safeguards.

With RES power plants an additional opportunity for hold-ups exist: As far as RES power plants are still not fully competitive with fossil and nuclear power plants, the external benefits of RES power plants due to e.g. reduced environmental impact and higher supply security needs to be remunerated. Public regulations are a way to create such extra-rents. The governance of the transaction between the generator and the purchaser of electricity converts to an 'administered contract' restricting the freedom of the transaction partners to design the governance themselves (Goldberg 1976). However, the state may appropriate these extra-rents by altering the regulation. Thus, a 'regulatory contract' (Bickenbach et al. 2002) has to provide comparable safeguards against hold-ups in the relation to the state.

### Governance Structure in the German EEG

In the following, we will describe the governance structure implied by the German *Erneuerbare-Energien-Gesetz* (EEG – Renewable Energy Act).

In Germany, the regulatory contract in the form of the EEG sets amount and minimum prices of any individual transaction between the generator<sup>16</sup> and obliged grid-operators. Thus the primary or main duties of such transaction are governed by the regulation. The relation between the grid-operator and the generator relies on the regulation and the state rather than on a contract between them. Exclusively secondary duties like payment plans, metering and so on might be content of a private contract between the purchasing grid-operator and the generator. If these secondary duties are regarded as minor, especially regarding the absolute volume of a certain transaction (e.g. with small PV installations), a contract between the grid-operator and the generator might even be obsolete. In fact, the regulation does not state whether a contract must be agreed on or not. In numerous cases, no contract has been made. Yet, legal practise has denied a generator's obligation to contract explicitly with of the grid-operator so far, which is a dubious position (Gent 2001, Brandt et al. 2001). Even though the regulatory contract may be seen as one between the state and the obliged grid-operator, the provisions of the regulatory contract interferes very much into the relation and the transaction between the generator and the grid-operator.

Compared to an RPS in the manner of the Texan regulation, the governance structure created by the German EEG can be understood as a more hierarchical one. In terms of 'make-or-buy' decision, the state has somewhat integrated the purchase of electricity into his own hierarchy. Concerning the grid-operator's role within the EEG, he can be regarded as an agent of the state especially as grid-operation - the main business of the grid-operator - is subject to public regulations. The relation between the state and the grid-operator as his acting agent bears many characteristics of an hierarchical governance. The EEG allows the obliged grid-operator no degree of freedom concerning the amount and the price to be paid for the electricity from RES. Consequently, the EEG provides no incentives to the grid-operator to decrease the price of generated electricity. The state maintains an accounting system to survey grid-operators. Moreover, a kind of audits of the generators are undertaken. The 250-MW-Wind-Programme which accompanied the similar predecessor of the EEG, the Electricity Feed-In Law (StrEG), forced participating wind-power-plant operators to reveal cost and performance data. Surveys on performance and costs are part of a biannual progress report<sup>17</sup>. Adaptations to changing conditions (e.g. cost development, technology deployment, technologies to be incorporated, grid access issues) are undertaken in a intentional and to some extent also cooperative manner.

It has to be underlined, that the above said applies only to transfers of electricity between the generator and the grid-operator. Pre-products, i.e. especially the power plants themselves, are still purchased on competitive markets, allowing the full benefits of such governance. For the sake of maximising their own profits, generators will go for as low as possible plant purchase prices. As a result, the value-added chain remains governed mostly by markets. Yet, the EEG implies that generators cannot force out business rivals by lowering electricity generation prices. Whereas in a competitive market relation between generators and electricity purchasers, a generator will be pushed out of the market in the long-run, if he does not optimise the input-output relation, this is not the case with the framework created by the EEG. Thus, generators might be more ready to share their quasi-rents with plant manufacturers. Especially, if supply of plants is scarce, plant manufacturers are in a good position to acquire parts of the quasi-rents. This way, parts of the quasi-rents due to the EEG might be passed on downwards the entire value-added chain weakening the high-powered incentives delivered by markets<sup>18</sup>. The state might even desire such rent-sharing to a certain extent since the extra quasi-rents allow reaping of returns from innovations thus supporting innovation (Viscusi

<sup>16</sup> Since the following sections will exclusively deal with power generation from RES we will refrain from marking generators as 'RES generators', power plants as 'RES power plants' or electricity as 'RES electricity' for the sake of better readability. If not other stated exclusively RES are covered.

<sup>17</sup> However, achieving precise and true data on the cost development of the different technologies for the purpose of price adaptation has been an challenge (Hirschl 2002). Enhancing access to cost data is one important issue to enhance the performance of the EEG.

<sup>18</sup> Indeed, rent-sharing with input suppliers is one reason why regulated firms are likely to face higher than competitive costs once a regulation is relaxed (Noll 1989, 1266).



et al. 2000,510). Furthermore, the extra motivation induced by the threat of being pushed out of the market would not come about without any extra cost since the additional risk, which investors have to bear, needs to be remunerated additionally.

### Governance Structure in the Texan RPS

In contrast to the German EEG, the regulatory contract in form of the Texan RPS sets only the minimum total amount of RES electricity. This implies especially that the regulatory contract does not fix any provisions in any dimension of the transaction between the obliged electricity supplier serving ultimate costumers and the generator. Compared to the obliged party in the EEG (the grid-operator), Texan electricity suppliers have a larger degree of freedom to fulfil their obligations. In particular, obliged suppliers may fix individual prices and individual amounts of purchased certificates and/or electricity in individual contracts with individual partners. They even get the freedom to integrate the RES power generation in their own business, too. Moreover, it is in the direct interest of the supplier to reduce his burden from the obligation. This is different from the motivation of the grid-operator as the obliged party in the German EEG, who has only an indirect motivation for cost reduction since as a regulated actor in a natural monopoly, he is principally able to pass on any burden to his customers. Thus, the relation between the state and the regulated entity is much looser in the Texan RPS than in the German EEG. This higher degree of freedom in Texas compared to Germany, from which potential efficiency gains accrue, offers the supplier also more opportunities for holding up the RES generator. Long-term contracts (if not entire integration) tend to be the resulting governance structure to safeguard the specific investment in the Texan RPS (Langniss, Wiser 2002). Thus, one has to distinguish between *ex-ante* contract and *ex-post* contract regarding the transaction relation between the obliged electricity supplier and the generator:

- As long as obliged electricity suppliers contract out their demand on RES certificates, a market type relation between the demander and the bidders exists *ex-ante*.

This fundamentally changes when a successful bidder enters into a delivery contract. These long-term contracts create a tighter, more hierarchical type of transaction. Not only price and amount is fixed by such contracts but additional provision like access rights to the facility, codes of conduct etc. create a hierarchical governance structure.

It gets clear that a specific investment in the form of a RES power plant needs safeguards against potential hold-ups in any case. Generators will not invest in specific assets as long as no sufficient safeguards against appropriation of quasi-rents by the obliged purchaser are in place. Long-term binding commitment and contracts are thus inevitable, as far as the power plant represents a specific investment. But these safeguards need not to be provided by the state in form of a regulation since private contracts can provide safeguards of the same quality. In other words: a lack of

safeguards by the regulation can be counterbalanced by additional safeguards in a private contract. The German EEG which delivers almost perfect safeguards against hold-ups, might be regarded as the most far-reaching attempt by the state to give secure and certain investment environment. The Texan regulation, on the other hand leaves a lot of freedom to the negotiating parties to deliver such safeguards.

### Resulting Hybrid Governance – a Comparison

Thus both support schemes result in hybrid governance structures. Yet, the regulatory contract within the German EEG has more characteristics of a hierarchy whereas in the Texan RPS the regulatory contract is shifted more towards a market-based governance. This means especially that the Texan regulatory contract provides more high-powered incentives for an efficient electricity generation with RES than the German EEG. Typically, in both cases, the character of governance of the regulatory contract is transferred to the individual transaction relations. Indeed, the German EEG already defines the primary duties of the purchaser on a long-term basis thus only secondary duties needs to be defined in an individual contract. As a result, there is no high-powered incentive by competition and market to raise efficiency.

In contrast, the market-oriented approach of the Texan RPS leads to competition among potential generators. Consequently, strong incentives to raise efficiency are provided in the pre-commissioning phase. This changes substantively once a long-term contract has been concluded<sup>19</sup>. The governance structure of the standard contracts<sup>20</sup> concluded typically provides only limited incentives to the generator to enhance efficiency further. For example, a generator receives the entire extra quasi-rent from an extended electricity generation, both in terms of electricity and certificates, only if this surplus generation does not exceed 5 to 10 % of the contracted amount<sup>21</sup>. Should the excess generation exceed these amounts, the generator needs to share the extra quasi-rents with the purchasing electricity supplier. Since the individual generator is forced to deliver the entire generation to the contracting electricity supplier, a delivery of excess electricity to other parties with the advantage of keeping the full extra quasi-rents is not possible either<sup>22</sup>. In contrast, within the propositions of the German EEG, any extra quasi-rents from extended generation will fall to the generator thus providing very high-powered incentives to increase production. The same applies to extra quasi-rents due to efficiency gains by lowering input.

<sup>19</sup> This is a fundamental transformation according to Williamson (1987,61).

<sup>20</sup> Our analysis relies on two model contracts (SWPSC 2000, TXU 2000) which were provided together with two request for proposals for certificates and electricity from RES. Albeit the realised contracts are staying undisclosed they have followed reportedly the model contracts to a very large extent. The demand created by the two requests covers approximately half of the entire demand for certificates (and RES electricity) in Texas.

<sup>21</sup> § 4.02 TXU 2000, § 7.2 in connection with § 8.4 SWPSC 2000

<sup>22</sup> SWPSC 2000,1; § 4.01 TXU 2000

In the framework of the Texan RPS, operators are usually bound to fixed operation rules negotiated with the purchasing electricity supplier<sup>23</sup>. Additionally, any changes in the setting of the plant are needed to be reported to and approved by the purchasing electricity supplier<sup>24</sup>. Thus, the RES generator has difficulties to hide from the purchasing electricity supplier extra quasi-rents due to lowered input. The need of approval of any alterations gives the purchasing electricity supplier a strong position in acquiring at least partly any extra quasi-rents, with the result that the generator's extra quasi-rents decrease. From the purchasing electricity supplier's point of view, these provisions are rational, because they ensure that he gets the opportunity to profit from any extra quasi-rents due to efficiency gains, even though he weakens the generator's incentives to perform such efficiency enhancements. Without these provisions, the purchasing electricity supplier will be foreclosed from any extra quasi-rents in any case. Thus, these provisions enhance the purchasing electricity supplier's chance to achieve extra quasi-rents. Albeit individual contracts do not need to contain such clauses, the rationale described above makes it very likely that such provisions are typical part of contracts. This applies as long as major parts of the life-cycle costs and thus optimisation opportunities due to input minimisation, occurring up-front before commissioning, as e.g. with wind power or hydro power. In contrast, contracts on the purchase of electricity from power plants, for which total generation costs consist of a larger share of running costs on the total generation costs (e.g. biomass fired plants), might contain more incentives for the plant operator to optimise operation. Table 1 summarises the typical governance structures established under the German EEG and the Texan RPS. In both cases, the governance structure created by the regulation is still maintained in the *ex-ante* contract phase. After concluding the contract (*ex-post*), the governance structure tends to the opposite. We will describe these shifts in more detail in the following.

Table 1. Qualitative assessment of typical governance structures within the German EEG and the Texas RPS.

	Regulatory Contract	Administered Contract	
		<i>Ex-ante</i>	<i>Ex-post</i>
<b>German EEG</b>	On electricity amount and price	Long-term contract on secondary duties	
	→ more hierarchy		→ more market
<b>Texan RPS</b>	On total electricity demand	Long-term contract on amount, price & secondary duties	
	→ more market		→ more hierarchy

In the Texan situation, restricting the generator's extra quasi-rents, and transferring at least parts of them to the obliged electricity supplier, means that in the end

the final consumer of electricity may benefit from the reduced costs. Arguably, competition among electricity suppliers must work to let final consumers benefit from reduced costs. Otherwise electricity suppliers would not be forced to supply at their marginal costs. Still, compared to the situation under the German EEG, Texan electricity customers have greater chances to benefit from reduced generation costs. Producers' surpluses will be reduced in favour of consumers' surpluses. Thus, the reduction of incentives to the generator comes together with a desirable distributional effect<sup>25</sup>.

Only in an RPS the generator has the opportunity to enlarge his individual quasi-rents by increasing the price whereas in the German EEG this is not possible. However, this opportunity is temporarily limited, since in the long-run obliged electricity suppliers would search for other sources of certificates, in case they got victims of a generator's hold-up. The generator's possibility to blackmail the obliged electricity supplier is actually an important pre-condition which forces the obliged entity into a long-term commitment with the generator in form of long-term contracts or even integration of the generator. Public regulation has to create two other major pre-conditions in order to push the obliged entity into long-term commitments which safeguard specific investments<sup>26</sup>:

1. The state has to commit reliably to long-term quantified targets for the supply of renewable energies.
2. The state has to impose sufficient sanctions on obliged entities that fail to meet their obligations.

These pre-conditions can be found in Texas. The temporary availability of public generation grants in form of the federal Production Tax Credit creates an additional momentum to conclude long-term contacts (Langniss, Wiser 2002). As a consequence of these grants wind power plants<sup>27</sup> commissioned at an early stage will generate cheaper electricity than plants erected later. Thus, it is favourable for the obliged electricity supplier to achieve and maintain access to these comparatively inexpensive sources of supply. Moreover, since certificates may be traded a surplus of certificates will not necessarily create a financial loss.

The German EEG leaves grid-operators no freedom in governing their transactions with RES generators as far as the major issues are concerned. Especially, they must not integrate directly the generator because by law grid-operation has to be separated from electricity generation. In contrast, an obliged electricity supplier in Texas has every freedom to govern the transaction with the generator. Therefore, one might ask why are long-term contracts the predominant form of governance in the Texan RPS right now? As described, a governance purely based on spot-markets would not

<sup>23</sup> For example §10.5(B) SWPSC 2000

<sup>24</sup> § 2.08 TXU 2000, §5.8 SWPSC 2000

<sup>25</sup> Efficiency and distribution are often interdependent in regulation (Noll 1989,1262).

<sup>26</sup> Rader, Hempling 2001, pp7, pp72

<sup>27</sup> As the principal generation technology with the lowest generation costs of all RES in Texas.



safeguard sufficiently specific investments in the power plant.

On the other hand why then is the operation of the power plants not entirely integrated in the business of the obliged electricity suppliers? Certainly, the hybrid governance created by the long-term contracts bears many characteristics of a hierarchy. Still, it is not entirely hierarchical. Transaction Cost Economics (TCE) gives some answers to this question also applicable to this case. TCE suggests that transactions should be governed by markets as much as possible to achieve the benefits of the high-powered incentives of market governance. Only if markets can not provide sufficient safeguards, hierarchies should come into play (Williamson 1987). Thus, as long as long-term contracts provide adequate safeguards, there is no need for the obliged electricity suppliers to fully integrate the plant operation in their business. Instead, they benefit from the high-powered incentives delivered by competition in the pre-commission phase. Moreover, economies of scale can be realised by bundling the demand of several obliged electricity suppliers through markets. Indeed, some of the wind parks developed for the RPS by a single developer are delivering to different electricity suppliers. Cost reductions by learning effects can be realised faster and to a larger extent, too, if the demand is bundled by markets. This is especially true considering that most obliged electricity suppliers so far lack experience with RES power plant development and operation. Good and abundant wind resources are situated in the western part of Texas but many suppliers do not have access to these good wind resources in their own ancestral supply area<sup>28</sup>. Thus, in most of the cases obliged electricity suppliers cannot realise economies of scope by bundling their conventional generation with the RES generation. As described earlier in this section, long-term contracts may limit the obliged electricity supplier's risk of appropriation of quasi-rents by the regulator. Against that, a total integration would put this risk completely on the electricity supplier.

In Texas, the strong incentives induced by the stronger market characteristic of the RPS regulation itself and within *ex-ante* contracting, are supplemented by weaker incentives due to more hierarchical governance *ex-post*. Moreover, it is in the direct interest of the supplier to reduce the burden imposed by the obligation. This is different from the position of the grid-operator as the obliged party in the German EEG. The German grid-operator has only an indirect motivation for hold-ups since as an actor in a regulated, natural monopoly he is able to pass on any burdens to his customers<sup>29</sup>. The German EEG creates just the opposite

distribution of the incentive quality: the regulation itself and resulting transaction relations *ex-ante* are featured by low-powered incentives whereas higher-powered incentives are in place *ex-post* (see Table 1).

### The Role of the State

In both regulations, the state in its role as legislator and regulator is a potential source for hold-ups. Phasing out the obligation would effectively appropriate quasi-rents accruing from power plants in both systems. While in the German EEG it is clearly the RES generator who will be ousted this way, within the Texan regulation it very much depends on the individual contracts between the generator and the electricity supplier who of these two parties will bear this risk. As far as documented by the two published standard contracts<sup>30</sup> representing the basis of this analysis of the Texan RPS, the obliged electricity supplier is not able to transfer his risk of appropriation by the state towards the generator. Still, contract terms which do not cover the entire usual economic life-time of a power plant are a way to shift parts of the risk of appropriation towards the generator. Yet, contract terms found in existing contracts exceed at least ten years and amount up to 25 years thus almost entirely excluding any risk for the generator caused by a phase-out of the regulation.

Due to the specific design of the EEG, the German legislator's possibility to appropriate quasi-rents is limited to power plants in construction but yet not commissioned. Beyond phasing out, regulators might chose to alter only parts of the regulation. In the German regulation, additional technologies might be incurred to be eligible for regulated remuneration, remunerations might be lowered for certain technologies or technologies already considered in the regulation might be differentiated to a higher degree. Again, this would apply only to new plants. Safeguards against appropriation by the state are delivered in three different interdependent means. First, the EEG as a regulation constitutes safeguards by fixing for example the remuneration for 20 years, or the terms when remuneration levels may be altered. Second, the "protection of legitimate expectations" through the German constitution provides a safeguard against a sudden phase-out of the regulation. Third, juridical decisions have enforced protection of legitimate expectations in the past. Thus all three restraints necessary for a satisfactory performance of a regulated industry (Levy, Spiller 1994,202) are in place. Also investments in plants not in operation are protected by provisions in the regulation as well as by constitutional rules against appropriation even though the protection is not as comprehensive as with generating plants.

This is different in the Texan regulation. Ending the obligation would result in an immediate appropriation of quasi-rents both from existing plants as well as from

<sup>28</sup> Deregulation has suspended most of the spatial monopolies. Thus electricity suppliers and electricity generators are free to erect and operate power plants in any place. Thus, the argument brought forward here is based on the historical development of power plant placing rather than on still existing spatial monopolies.

<sup>29</sup> This prescinds from potential hold-ups, which the regulator may impose on the grid-operator by e.g. lowering regulated grid-tariffs. However, regulatory supervision of grid-tariffs is generally viewed as having been weak so far. In Germany, electricity grids are owned and operated by large integrated utilities. Unbundling is only re-

quired in accounts. Therefore, grid-operators might act as agents for certain electricity suppliers. They are indirectly motivated to hinder any form of additional electricity generation including that of RES electricity under the EEG.

<sup>30</sup> SWPSC 2000, TXU 2000

plants in construction. As long as a homogeneous quota, i.e. a single requirement for all RES technologies, is maintained, any reduction of the total level of the obligation in terms of MW, any suspension of the required amounts and/or any alteration of the RES technologies to be favoured will result in lower prices thus an appropriation. Thereby, the alteration of RES technologies eligible for the RPS has two effects. In case certain technologies are excluded, the specific investments in these technologies will be devaluated. At the same time, *ceteris paribus* the value of the other technologies will be increased. Incorporating additional technologies will have the opposite effect. The new technology will gain value, the others will be devaluated. Whereas the direction of effects from any kind of alteration is clear it is uncertain to which extent quasi-rents from specific investments will decrease since it is the market which decides on the equilibrium prices and amounts. Thus, there is high uncertainty incorporated with any decision on an alteration of RPS regulations.

Table 2. Comparison of coverage of protection against appropriation of quasi-rents by the state on different institutional levels.

	Private Contract	Regulation	Constitution
<b>German EEG</b>	Secondary duties	<ul style="list-style-type: none"> <li>• Individual price and amount</li> <li>• Term of remuneration</li> <li>• Alteration of prices</li> </ul>	Protection of legitimate expectations
<b>Texan RPS</b>	<ul style="list-style-type: none"> <li>• Individual price and amount</li> <li>• Term of remuneration</li> </ul>	<ul style="list-style-type: none"> <li>• Total amount</li> <li>• Term of obligation</li> <li>• Alteration of obligation</li> </ul>	Recovery mechanisms

Within the deregulation of the electricity industry in Texas, comprehensive regulations have been established on stranded investments<sup>31</sup>. These rules basically allow investors to recover costs due to investments which were undertaken under a regulated framework but which are now stranded because of deregulations. This applies especially to nuclear power plants. A 'Competition Transition Charge' was established to finance the extra costs from this cost recovery. Albeit under the Texan RPS, these rules are not applicable to specific investment, their existence raise expectations on the treatment of substantive appropriation of specific investments the latter nothing else then stranded costs by definition. Investors in power plants may expect similar cost recovery mechanisms as the ones now established, in case changes of regulations would devaluate substantially their investment.

<sup>31</sup> § 39.251 - § 39.265 Texan Public Utility Regulation Act (PURA) called 'subchapter F: Recovery of Stranded Costs through Competition Transition Charge'.

## Conclusion

Transaction Cost Economics sees two generic alternatives to reduce risks from hold-ups: Contracts are a feasible choice as long as they can be sufficiently complete to ward off the main risks. If this is not the case transaction partners are likely to be integrated. With the state as a player a third alternative comes into play: regulation (Williamson 2000).

The possible design of this different means varies in practise over a broad range. Under the German EEG, as well as under the Texan RPS sufficient means may be developed to limit the threat of hold-ups. The specific investment into power plants can be sufficiently safeguarded against the threat of hold-ups. Thus, these hold-ups do not create insurmountable barriers for the introduction of RES in either of the two support scheme analysed. Yet, rather different means have been established to govern the transactions in both states. Hence, different parties have the opportunity to hold-up due to the different design of the support mechanism.

Within the Texan RPS, generators have strong incentives to reduce generation costs *ex-ante*. After entering a long-term contract, these incentives are weakening by specific propositions. In contrast to that, the degree of generator's incentive to decrease generation costs stays the same *ex-ante* and *ex-post* in the German EEG. Thus, albeit competition within an RPS provides probably more incentives *ex-ante*, incentives *ex-post* may be larger within an MPS. Efficiency gains of an RPS compared to a MPS are therefore smaller as economic theory would suggest.

Thus, if a successful<sup>32</sup> MPS regulation has been established in a certain country the benefits of enhanced competition are very likely to be smaller than the risks associated with an introduction of an RPS.

## Acknowledgements

Work reported here was funded by the European Commission (Contract MCFI-2000-01067). I like to thank Peter Helby (Lund University), Reinhard Madlener (CEPE, ETH Zürich), Joakim Nordqvist (Lund University) and Aviel Verbruggen (STEM, University of Antwerpen) for instructive comments.

## Literature

- Berry, T.; Jaccard, M. (2001): The Renewable Portfolio Standard: Design Considerations and an Implementation Survey. *Energy Policy*. 29. 263-277.
- Bickenbach, F.; Kumkar, L.; Soltwedel, R. (2002): Wettbewerbspolitik und Regulierung. Die Sichtweise der Neuen Institutionenökonomik (Competition policy and regulation. The view of the New Institutional Economics) In: Zimmermann, K.(ed.): Neue Entwicklungen in der Wirtschaftswissenschaft. Heidelberg, p. 217-275.
- Brandt, E.; Reshöft, J.; Steiner, S. (2001): Erneuerbare-Energien-Gesetz. Handkommentar. Baden-Baden
- Gent, K. (2001): Der gesetzliche Anspruch auf Strominspeisung (The legal claim for feeding-in electricity). *Zeitschrift für Neues Energierecht*. 5, 237-238.
- Goldberg, V. (1976): Regulation and administered contracts. *Bell Journal of Economics*. 7. 426-448

<sup>32</sup> in terms of additional RES capacity

- Hirschl, B. (2002): Vergütungssätze des EEG und Stand der technischen Entwicklung (Remuneration tariffs of the Renewable Energy Act and the State of the Technical Development). Presentation. Conference „Das Erneuerbare Energien Gesetz. Zwischenbilanz und Perspektiven“ (The Renewable Energy Act. Interim result and perspectives). Bonn February 16<sup>th</sup>/17<sup>th</sup>.
- Langniss, O.; Wiser, R. (2002): The Texan Renewable Portfolio Standard. An Early Assessment. *Energy Policy*. Forthcoming.
- Levy, B.D., Spiller, P. (1994): The Institutional Foundations of Regulatory Commitment : A comparative analysis of Telecommunications Regulation. In: *The Journal of Law, Economics & Organization*. 10/2, 201-246.
- Nakicenovic, N. et al.(2000): Energy Scenarios. In : Goldemberg, J. (ed): World Energy Assessment. New York. 333-366.
- Nitsch, J. et al. (2000): Klimaschutz durch Nutzung erneuerbarer Energien. Berlin.
- Noll, R.E. (1989): Economic Perspectives on the Politics of Regulation. In: Schmalensee, R.; Willig, R.D.(eds.): Handbook of Industrial Organisation. Vol. II. 1253 –1287.
- Rader, N.; Hempling, S. (2001): The Renewables Portfolio Standard. A Practical Guide. Prepared for the National Association of Regulatory Utility Commissioners.
- Richter, R.; Furubotn, E. (1999): Neue Institutionenökonomik. 2. Auflage. Tübingen..
- Simon, Herbert A.: Models of man. Social and rational. New York London. 1957
- SWPSC Southwestern Public Service Company (2000): 2000 Renewable Energy Credit. Request for Proposals for Southwestern Public Service Company (RFP). With annexed Model Contract. March 2000.
- TXU Electric Company (2000): 2000 Renewable Energy. Request for Proposals (RFP). With Standard Purchase Agreement. <http://www.txu.com/business/powersupply>. January 2000.
- Viscusi, W.K.; Vernon, J.M.; Harrington, J.E. (2000): Economics of Regulation and Antitrust. 3<sup>rd</sup> edition. Cambridge, London.
- Williamson, O.E. (1987): The economic institutions of capitalism. New York.
- Williamson, O.E. (2000): The New Institutional Economics: Taking stock, looking ahead. *Journal of Economic Literature* 38. 595-613.

## Regulatory and Institutional Innovation for the Promotion of Renewable Energy Use

Reinhard Madlener, CEPE – Centre for Energy Policy and Economics, Zurich, Switzerland<sup>33</sup> and  
Eberhard Jochem, CEPE and Fh-ISI – Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany<sup>34</sup>

**Keywords.** Renewable energy, Promotion policy, Regulation, Feed-in tariffs, Green certificate trading, Quota system, Technology diffusion, Institutional innovation, Supply diversity

**Abstract.** In this paper we study regulatory and institutional innovations required for an accelerated market diffusion of new renewable energy technologies. The main focus is on the situation in Europe. The paper argues that the existence of incentive-based promotion schemes is just one of several of the necessary conditions that must be fulfilled in order to allow renewables to penetrate the energy system in the politically desired intensity. The main conclusion drawn from the analysis is that in order to successfully initiate and perpetuate the market diffusion of renewables, in most cases it will be useful to identify and tackle the most important latent drivers and obstacles involved jointly and in a systemic and actor-oriented approach.

### Introduction

New renewable energy technologies (RETs) are an important element for the long term transition towards a more sustainable energy system, and a more sustainable society and economy. Over the last decade, despite a still very low average contribution to overall energy supply in most countries (which at the global scale still relies to 80% on fossil fuels today; UNDP/UNDESA/WEC 2000), several of these technologies have experienced double-digit growth rates in market diffusion in some European countries (e.g. Kaltschmitt et al. 2002; Johnson & Jacobsson 2000), and making substantial progress along the learning curve (e.g. Isoard & Soria 2001; Nitsch, 1999; Neij 1997).

The diffusion of many new renewable energy technologies has begun in the 1980s or 1990s, starting with the use of methane from landfills and waste water treatment plants, the passive and active use of thermal solar energy, the re-vitalisation of small hydro power, the first automation of wood-fired boilers and ovens, as well as with bio-diesel and ethanol from biomass as vehicle fuels. In terms of capacity installed, wind power and solar collector systems have been particularly successful in some European countries and in Asia in the 1990s and received much attention; they can, therefore, serve as models for the increased utilization of other RETs. Especially wind power presently

<sup>33</sup> ETH Zentrum WEC, CH-8092 Zurich, Switzerland. Tel. +41-1-632 06 52; Fax: +41-1-632 10 50;  
Email: madlener@cepe.mavt.ethz.ch

<sup>34</sup> Breslauer Strasse 48, D-76139 Karlsruhe, Germany. Tel. +49-721-680 91 68; Fax: +49-721-680 92 80,  
Email: eberhard.jochem@isi.fhg.de

exhibits an enormous growth potential, as most of the material problems concerning the rotor which were most crucial in the past century (Heymann 1996) have been solved by now. This was an important precondition for a successful scaling-up of capacity, so that today learning effects and economies of scale and scope are becoming major drivers (Gipe 1995; Isoard & Soria 2001; Johnson & Jacobsson 2001), also with regard to exports (Jochem et al. 2002).

Energy policy-makers and the related administrative bodies often focus their efforts primarily on R&D funding and the provision of financial incentives for the investment or operation of RETs (e.g. capital and/or operating & maintenance cost subsidies). The many additional factors that are potentially relevant for the diffusion of innovative RETs and for the various actors supporting the diffusion process are typically much less well understood and considered in policy design.

Incentive-based regulatory promotion schemes, typically in the form of guaranteed feed-in tariff systems, quota-based tradable certificate systems, and bidding systems, have been intensively studied in recent years (e.g. Madlener & Drillisch 2002; Menanteau et al. 2001; Espey 2001; Morthorst 2000; among many others) and are meanwhile in place in most of the EU Member Countries. They are presently considered as key to increase the market penetration of renewables, as foreseen, for example, in the

- 1997 EC White Paper "Energy for the Future" (CEC 1997), which calls for a doubling of the share of renewables from 6 to 12% in overall gross inland energy consumption by 2010, and the recently signed
- EU Directive 2001/77/EC on the promotion of electricity from renewables (CEC 2001), which contains indicative target shares for renewables for each of the EC member countries until 2010.

Both documents clearly signal the willingness of the European Union and its member states to set and pursue ambitious steps to raise the contribution made by RETs in the energy supply system. Given the political challenges implied by these targets (and related sub-targets and efforts), and the momentum created at various levels, it becomes crucial to study the effectiveness both of existing and planned future policies and of the institutional frameworks in the EU and its Member Countries in influencing the speed of diffusion of particular renewable energy technologies.

Recently, several researchers have made attempts to design system-based analytical frameworks to address the diffusion of renewable energy technologies (e.g. Fuchs & Arentsen 2002; Painuly 2001; Jacobsson & Johnson 2000; Loiter & Norberg-Bohm 1999; Roos et al. 1999). The goal of this rather exploratory paper is to add to this body of literature by studying the diffusion of innovation process in a broader interdisciplinary context of actors, their networks, and institutional settings, applying the concepts of barriers and latent drivers. Based on this analysis, policy instruments and measures of involved actors are discussed in their abil-

ity to stimulate technological progress and further market penetration of renewable energy technologies.

Particularly, we address the regulatory and institutional innovations needed for an increased diffusion of RETs by focusing on six aspects: (a) cost reduction potentials of new RETs; (b) know-how of the actors involved (e.g. investors, planners, architects, bankers, installers); (c) risk perception, lack of experience; (d) legal framework conditions; (e) technology competition; and (f) resistance of existing market players. We discuss these aspects by choosing illustrative examples for selected RETs in EU Member Countries, which can help to better understand the problems, possible remedies, and chances incurred.

The remainder of the paper is organised as follows: we will first shed some light on the role of barriers and latent drivers for the diffusion of renewable energy technologies. Second, we introduce factors influencing the diffusion rate of innovations from the diffusion theory literature. Third, for the six aspects (a)-(f) mentioned above, we analyse the policy actions needed to induce regulatory and institutional innovations, giving particular attention to actor- and network-related policy instruments that can help to foster the diffusion of RETs, followed by the conclusions drawn from the analysis.

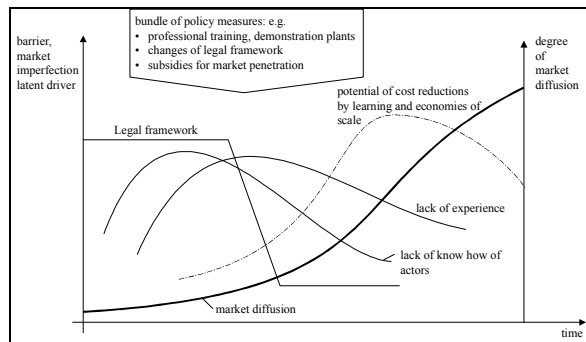
### Barriers and latent drivers

The diffusion of RETs crucially depends on existing barriers and (latent) drivers. *Barriers* include market, network and institutional failures, such as

- Lack of technological knowledge and market survey of relevant actors (e.g. installers, planners, architects, potential investors) and their professional associations;
- Lack of financial flexibility of small businesses, newly founded companies, and home owners, as RETs are typically considerably more capital-intensive, compared to traditional energy conversion technologies;
- Legal and administrative obstacles; such as regional construction ordinances, traditional decision making or distrust of officials of local or regional authorities against new technologies;
- Price distortions (external costs of traditional heat and electricity generating systems not taken into account, such as environmental pollution along the energy chain, uncovered risks of major accidents etc.), or
- Market power abuse of early entrants for the case of grid-based energies, such as large or local electricity, gas or district heat utilities, e.g. by offering very low feed-in tariffs or by asking for extremely high safety and measurement investments at the interconnection point, and/or high prices for remaining energy deliveries or maintenance power.

For a further discussion of barriers for the long-term integration of RETs in Europe see for example Hohmeyer et al. (1998: esp. Chapters 4 and 5). Most important here is the observation that several of the mentioned barriers exist simultaneously, forming a com-

plex which may have to be alleviated by a bundle of synchronised parallel policy measures (see Figure 1 and 2). Figure 1 illustrates this aspect of timing as a crucial factor faced by policy-makers trying to reduce barriers, and to activate latent drivers for an accelerated market diffusion of renewable energy technologies.



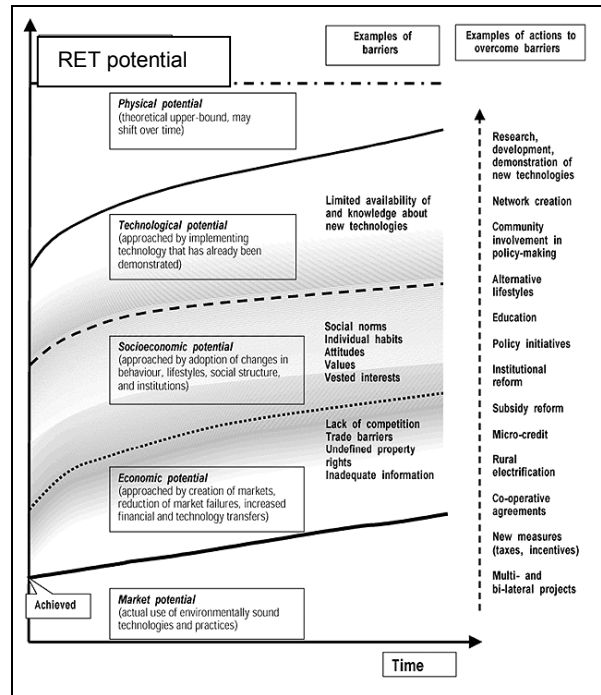
Source: own illustration

Fig. 1. Timing and intensity of barriers and of latent drivers as challenges for a policy to accelerate market diffusion of renewable energy technologies

Figure 2, taken from the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC 2001) and adapted for RETs, provides some examples of barriers at the various RET potential levels, together with examples of measures to overcome these barriers. In our opinion, this kind of graphical representation can provide highly useful hints for interdisciplinary and systematic discussions on which and how certain barriers can hinder the exploitation of the various RET potentials over time and how they can be successfully tackled.

There has been much attention to barriers and market imperfections in the last two decades, representing a rather mechanistic concept of innovation and technology diffusion. So far, however, rather little attention has been dedicated to *latent drivers* being able to promote the diffusion of renewables (Jochem et al. 2000; Rennings 2000); such drivers may include the

- cost reduction potentials gained by learning effects and economies of scale and scope (both in equipment manufacturing and use),
- readiness of associations of technology suppliers, installers, contracting companies and energy users to undertake marketing, professional training and procurement programmes, possibly additionally supported by environmental groups or home savings banks, or the
- internalisation of the externalities of fossil fuel use, accepted maybe even voluntarily by some investors in the residential, business or public sector, creating a policy climate in administration and policy-making that allows to develop the acceptance of a gradual introduction of energy taxes, emission certificates, or specific regulations or boundary conditions for the diffusion of renewables in a liberalised energy market.



Source: adapted from IPCC (2001), Fig. 5.1

Fig. 2. Barriers and different potential levels renewable energy utilization

## Factors influencing the rate of diffusion of innovations

The term 'diffusion of innovation' refers to the process by which an innovation is communicated through certain channels over time among the members of a social system (see Rogers 1995: Ch.1; Dosi 1982). In diffusion theory, one may distinguish between the following factors that influence the rate of diffusion of innovations (Rogers 1995: Ch.6):

- Perceived attributes (relative advantage, compatibility, complexity, trialability, observability);
- Type of innovation decision (optional, collective, authoritative);
- Communication channel/s used;
- Nature of social system;
- Extent of change agents' efforts.

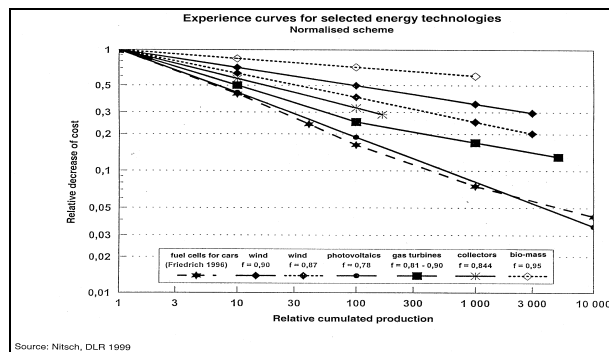
Given the large range of influencing factors, RET technologies, applications, and types of adopters, it is obvious that there is no such thing as a simple recipe for the successful promotion of RET diffusion. Besides, in the past especially change agents have often overemphasized adoption per se, neglecting possible undesirable consequences of innovation diffusions, which calls for a considerate, careful, and sufficiently forward-looking approach.

## Regulatory and institutional innovations needed and policy actions recommended

In this section we discuss, for the six selected aspects mentioned earlier, problems and solutions in the context of RET diffusion, and the public policy action needed to foster regulatory and institutional innovation for the promotion of RETs.

(a) Cost reduction potentials of new RETs

Experience, e.g. gained from the wind power industry, has taught that a promising RET strategy seems to be the following (Haier 1998): Start with small production levels and relatively high R&D costs per unit produced. Second, increase conversion efficiencies, material efficiencies, and labour productivities. Third, scale up product capacities. Fourth, exploit cost degression potentials by economies of scale (automated production) and scope (system integration), which can be expected to be significant (see Figure 3).



Source: Nitsch (1999)

Fig. 3. Experience curves for selected energy technologies

Feed-in laws for electricity fed into the grid, like in Germany, Spain and France, demonstrate the necessity that policy-makers establish stable boundary conditions for the creation of an investor-friendly climate in the market for new renewable energy technologies and services, so that the cost reduction potentials can actually be successfully exploited.

(b) Know-how of actors

New technologies and the related know-how have to be absorbed by all relevant actors involved:

- new groups of investors (e.g. home-owners, farmers, new SMEs) need information and education;
- change agents (e.g. traditional planners, architects) need professional training and education;
- traditional installers need to know how to integrate new systems and how to deal with the new professional environment (work on roofs, at farms, etc.);
- new and traditional finance bodies (e.g. development companies, venture capital financiers, contractors) are in need for technical consulting services.

Depending on the stage of the adoption process and the type of potential adopter(s) involved, *word-of-mouth information* (close to the decision) or *mass communication channels* (first information, raising awareness) are more appropriate (see Rogers 1995) for a successful diffusion of innovations.

Therefore, policy-makers should carefully think about the most appropriate communication channels, and put their emphasis on group-specific information, professional training, changes in education, and technical consulting for finance market actors (e.g. banks).

An interesting example for a successful training project in sustainable energy technologies provides the VOCATIONES project within the Leonardo da Vinci programme of the European Union undertaken in Romania (Fara et al. 2002).

(c) Risk perception, lack of experience

Many RETs are linked to some kind of supply- and/or demand-side disadvantage of intermittent production. Modern control technologies and intelligent system combinations can alleviate this problem, but back-up capacities for electricity and/or heat supply in times of low production output may still be required.

Another risk factor is the often to a large extent still unknown performance of the technology involved, e.g.

- Operational performance under unfavourable conditions; (e.g. off shore wind turbine parks);
- Health and safety aspects (e.g. occupational accidents);
- Uncertainty about market size and price developments, often aggravated through unstable boundary conditions of energy policies;
- Unknown costs of maintenance;
- rRisks from starting too big / neglect of scaling up (e.g. the German 3 MW wind turbine GROWIAN failed mainly because some components still had severe weaknesses, while at the same time smaller Danish wind turbines had already proven their reliability in practical use; Gipe 1995; Heymann 1996; Johnson & Jacobsson 2001).

Finally, also the risk perception both of the public and of funding institutions are crucial (Johns & Bouillé 2002; Wohlgemuth & Madlener 2000).

Policy-makers should therefore take into account that renewable energy policies may have a strong influence on the risk premiums asked for by investors, creating repercussions on the financing structure of renewables projects. A much better understanding on how policy design may affect project development and financing processes is needed, and financial assistance programmes for the promotion of RETs need to be predictable and stable over some time in order to support the attraction and confidence of investors and intermediaries in the new market.

(d) Legal framework conditions

Adequate legal framework conditions are an important prerequisite for a successful penetration of new RETs (e.g. building codes, planning procedures, financial support schemes, fair grid access, break-up of technological "lock-in" situations by allowing for the formation of niche markets).

Sometimes, especially in the course of market liberalisation, adaptations to the legal framework have been lagging behind in order to conserve existing structures as long as possible (such as in France in the case of the electricity market opening), or they bear more inertia for a transparent and fair grid use pricing than others (an example is the negotiated third-party-access regulation in Germany, as compared to the regulated TPA in all other EU member countries).



A second important aspect is the credibility and continuity of renewable energy promotion targets. The European White Paper COM(97)599 (CEC 1997), the Campaign for Action (CEC 1999), the Directive for the promotion of renewables (CEC 2001), and other important documents at the European level have been able to send consistent and strong signals in this direction.

Similarly, the Renewable Energy Act in Germany (EEG 2000), despite its turbulent birth, has maintained an active and rather stable market environment, and currently serves as a model for many other European countries. In contrast, renewable energy promotion in Austria has been very heterogeneous across the nine federal provinces, and has been subject to frequent and not always predictable adaptations in recent years, and is only currently in the process of being streamlined in a Renewable Energy Act (Ökostromgesetz 2002).

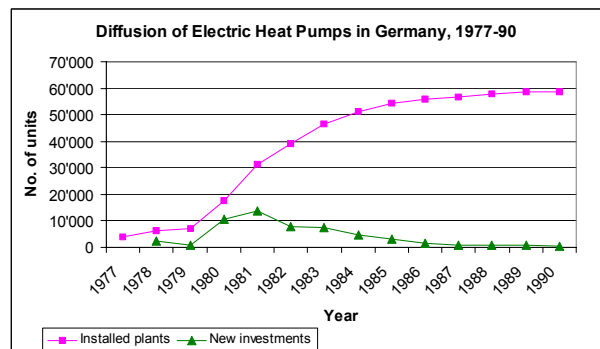
Finally, changes in governments, such as recently experienced in Denmark, can lead to sudden changes in policy; such changes are less likely if policies are based on parliamentary (and ideally unanimous) consent among the political parties and/or enshrined in laws.

☞ Hence policy-makers should make better use of the virtues of credible policy announcements that improve the investment climate and overall RET market attraction (“announcement effect”).

*(e) Technology competition with traditional technologies and partially among other new RETs*

New RETs may pose a challenge and a threat to traditional technologies that can lead to significant (and often unanticipated) further improvements of the latter. An example provides the diffusion of electric heat pumps in Germany in the early 1980s, which induced technical progress in burners, condensing boilers, control techniques, and insulation of boilers, which in turn significantly slowed down the penetration of heat pumps throughout the 1980s and early 1990s (see Figure 4).

In two seminal articles, Arthur (1989) and David (1986) have shown that technologies being less efficient than others may nonetheless become “locked-in” over time, mainly because of increasing returns that accrue from positive network externalities. Ways to escape such lock-in situations, which currently constitute a major barrier for new RETs, include crises in an existing technology (e.g. nuclear accidents), re-regulation, radical innovation changes in lifestyle and taste, and the emergence of niche markets (e.g. Cowan & Hultén 1996; Islas 1997; Menanteau 2000; Unruh 2000, 2002).



Source: FhG-ISI

Fig. 4. Diffusion of electric heat pumps in Germany, 1977-1990

In this context it is worth mentioning that the escape out of a technological lock-in situation does not necessarily imply the creation of another lock-in, as it may also lead to an increase in diversity due to a further segmentation of the range of product/technology applications. The simultaneous spread of condensing boilers, heat pumps and solar thermal collector systems in many European countries in this decade may illustrate this increased diversity. In order to ameliorate technological lock-in, it is important to continuously eliminate existing market entry barriers. Quota-based tradable green certificate (TGC) schemes, for example, aim to achieve dynamic efficiency by fostering the market entry of new players.

Consequently, in order not to grossly overestimate RET potentials, it is important that both policy-makers and market players calculate the market and innovation potentials for RETs also on the basis of the remaining potentials of the traditional and of the potentials of other competing RET technologies. Moreover, lock-in situations should be avoided by creating an open market environment.

*(f) Resistance of existing market players and formation of new players*

• *Actors*

The transition to a different energy supply system with a new technology mix requires the existence of strong actors, or groups of actors, who push innovative energy technologies forward and help to change regulations and institutions (Edquist 1997). *Prime movers*, such as multinational enterprises or networks of smaller actors, are key actors. In contrast to small single or non-organised actors, they have the potency to raise large-scale funding, to invest substantially (e.g. in R&D and marketing), to raise public and political awareness, and to diffuse new technologies (Johnson & Jacobsson 2000: 636) to a critical mass level where their further penetration becomes self-propelled (in the innovation diffusion literature a market penetration of between 10-25% of the saturation level is often considered sufficient; cf. Rogers 1995: Ch.8).

Installers, planners, architects and other important actors may not recommend systems they are not very familiar with. A good example is the diffusion of solar thermal heating systems in Austria, which was launched by DIY groups and only later adopted by

commercial actors (Ornetzeder 2001). Similarly, modern and often automated small-scale biomass heating systems suffered from the fact that installers preferred to install oil- and natural-gas-fired heating systems with which they were much more acquainted, and from unjustified image problems (e.g. regarding operating comfort, reliability, greenhouse gas and pollutant emission levels).

Another group of actors that has seen the diffusion of RETs mainly as a threat are transmission and grid operators (Isoard & Soria 2001: 631). They have often tried to hinder the feed-in of electricity from (renewable and non-renewable) distributed generation plants by charging excessive grid-use tariffs or by asking for expensive safety and measurement investments.

#### • *Networks of actors and institutions*

Existing energy market players often have strong and long-established associations that resist change. In some countries, such as Germany, industrial associations continue to play an important political role (e.g. in the set-up of the agreement of negotiated access of small generators and related grid-use tariffs).

Likewise, it is important for renewable energy actors to form associations (e.g. many national wind power associations are very powerful and influential in lobbying). However, associations for different renewable energy technologies do not always manage to effectively co-operate against competing non-renewable energy technologies, and tend to only lobby for their own technology (instead of simultaneously lobbying for complementary RETs and efficient energy use as well in order to achieve a greater overall impact on the transition of the energy system towards more sustainability).

Consequently, the requested structures for a successful and actor- and network-related promotion policy for the diffusion of new RETs comprise

- Political support by members of parliament, administration, and others (e.g. for setting appropriate boundary conditions in the liberalised energy markets);
- Powerful associations that are initiated and subsequently supported either by proponents (such as EUROSOLAR) or technology producers and/or adopters (e.g. German Association Biogas, German Federal Association of Wind Power, European Renewable Energies Federation – Eref, among many others);
- Legitimisation and support by consumer associations (information, consulting, joint procurement initiatives);
- Promotion of R&D networks (e.g. by means of EC research funding) and competence centres (e.g. RENET-Austria in Guessing for energy from biomass; European Joint Study Centres);
- Professional training of supply-side actors, such as planners, architects, installers, bankers (e.g. by involving them in the set-up and running of pilot and/or demonstration plants);

- Education of the demand-side actors (potential adopters), and more generally the public.

### Conclusions

In this paper we have studied regulatory and institutional innovations that help to foster the diffusion of renewable energy technologies.

The transition to an energy system that is more reliant on renewable energy sources implies a higher diversity of supply. It rests upon the simultaneous dismantling of barriers and activation of latent drivers, and in particular the existence of powerful actors, the establishing of institutions and well-designed networks, and the build-up of competence.

Finally, the analysis has shown that the long-term transition to sustainable energy systems needs a holistic policy strategy, i.e.

- The simultaneous activation of latent drivers and a reduction/elimination of existing barriers;
- Adequate boundary conditions in liberalised markets, clear and continuous signals of prices and objectives (e.g. cost reductions);
- Clear information about cost and emission reduction potentials of traditional technical alternatives;
- Well-informed and well-educated investors, planners, installers, maintenance staff etc.
- Strong associations of technology producers and users for quick collection and exchange of experience, quality control, information and professional training, marketing and lobbying (build-up of competence).

### References

- Arthur, W.B. (1989), Competing technologies: Increasing returns and lock-in by historical events, *Economic Journal*, 99(1), 116-131.
- CEC (1997), Energy for the Future: Renewable Sources of Energy. White Paper for a Community Strategy and Action Plan, COM(97)599 final as of 26 November 1997, Brussels: Commission of the European Communities.
- CEC(1999), Energy for the Future: Renewable Energy Sources, Campaign for Take-Off, DGXVII, Commission Services Paper SEC(1999) 504, Brussels, 9 April 1999.
- CEC (2001), Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market, OJ L 283/33, 27 October 2001, Brussels: Commission of the European Communities.
- Cowan, R.; Hultén, S. (1996), Escaping Lock-In: The Case of the Electric Vehicle, *Technological Forecasting and Social Change*, 53: 61-79.
- David, P.A. (1986), Clio and the Economics of QUERTY, *American Economic Review*, 75(2): 332-227.
- Dosi, G. (1982), Technological paradigms and technological trajectories. A suggested interpretation of the determinants and directions of technical change, *Research Policy*, 11: 147-162.
- Edquist, C. (1997), *Systems of Innovation: Technologies, Institutions and Organizations*. London: Pinter.
- EEG (2000), Gesetz für den Vorrang Erneuerbarer Energien (Erneuerbare-Energien-Gesetz – EEG), Bundesgesetzblatt Jg. 2000 Teil I Nr. 13, Bonn, 31 March 2000.



- Espey, S. (2001), Renewables portfolio standard: a means for trade with electricity from renewable energy sources?, *Energy Policy*, 29(7), 557-566.
- Fara, L.; C. Gutierrez; S. Fara (2002), Leonardo da Vinci Project Results Concerning Training in Sustainable Energy Technologies, *Proceedings of the World Renewable Energy Conference VII*, Cologne, 29 June – 5 July 2002.
- Fuchs, D.A.; Arentsen, M.J. (2002), Green electricity in the market place, *Energy Policy*, 30(6): 525-538.
- Gipe, P. (1995), *Wind energy comes of age*, John Wiley & Sons, New York.
- Haier, S. (1998), *Grid-Integration of Energy Conversion Systems*, New York: John Wiley.
- Heymann, M. (1996), Lost hopes and opportunities. The history of the use of wind power 1890-1990 (in German) Munich: Deutsches Museum.
- Hohmeyer, O.; Bräuer, W.; Groscurth, H.-M. (1998), Bottlenecks and Obstacles – Success Stories and Measures, in: The LTI-Research Group (ed.), *Long-Term Integration of Renewable Energy Sources into the European Energy System*, Heidelberg/New York: Physica-Verlag.
- IPCC (2001), Climate Change 2001: Mitigation. In: B. Metz, O. Davidson, R. Swart and J. Pan (eds.), Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge/UK: Cambridge University Press.
- Islas, J. (1997), Getting round the lock-in in electricity generating systems: the example of the gas turbine, *Research Policy*, 26(1): 49-66.
- Isoard, S.; Soria, A. (2001), Technical change dynamics: evidence from emerging renewable energy technologies, *Energy Economics*, 23(6): 619-636.
- Johnson, A.; Jacobsson, S. (2000), The diffusion of renewable energy technology: an analytical framework and key issues for research, *Energy Policy*, 28(9): 625-640.
- Jochem, E., Madlener, R., Mannsbart, W. (2002), Renewable Energy Technology Diffusion: Prospects of the German and Swiss Industry in the World Markets, *Proceedings of the World Renewable Energy Congress VII*, Cologne, 29 June – 5 July 2002.
- Jochem, E. Sathaye, J. Bonille, D., eds (2000), Society, Behaviour, and climate change Mitigation, Dordrecht/Boston: Kluwer Academic Publishers.
- Johns, J.; Bouillé, A. (2002). The Role of Private Equity in the New Renewable Energy Technology Sector, *Proceedings of the World Renewable Energy Conference VII*, Cologne, 29 June – 5 July 2002, Amsterdam/New York: Pergamon Press.
- Johnson, A.; Jacobsson, S. (2001), The Emergence of a Growth Industry: A Comparative Analysis of the German, Dutch and Swedish Wind Turbine Industries. Forthcoming in: Metcalfe, S. and Cantner, U. (eds): Transformation and Development: Schumpeterian Perspectives (provisional title), Heidelberg: Physica/Springer.
- Kaltschmitt, M.; Merten, D.; Falkenberg, D. (2002), Regenerative Energien (in German), *BWK*, 54(4): 66-74.
- Loiter, J.M.; Norberg-Bohm, V. (1999), Technology policy and renewable energy: public roles in the development of new energy technologies, *Energy Policy*, 27(2): 85-97.
- Madlener, R.; Drillisch, J. (2002), Tradable Certificate Schemes for Single Renewable Electricity Technologies: The Case of Small-Scale Hydro Power Promotion in Austria, *Proceedings of the 25<sup>th</sup> Annual IAEE International Conference "Innovation and Maturity in Energy Markets: Experience and Prospects"*, Aberdeen, 26-29 June 2002.
- Menanteau, P. (2000), Learning from Variety and Competition Between Technological Options for Generating Photovoltaic Electricity, *Technological Forecasting and Social Change*, 63(1): 63-80.
- Menanteau, P.; Finon, D.; Lamy, M.-L. (2001), Prices versus quantities: Environmental policies for promoting the development of renewable energy, *Cahier de Recherche No. 25*, Institut d'Economie et de Politique de l'Energie (IEPE), Grenoble, May.
- Morthorst, P.E. (2000), The development of a green certificate market, *Energy Policy*, 28(15), 1085-1094.
- Neij, L. (1997), Use of experience curves to analyse the prospects for diffusion and adoption of renewable energy technology, *Energy Policy*, 23(13): 1099-1107.
- Nitsch, J. (1999), personal communication.
- Ornetzeder, M. (2001), Old Technology and Social Innovations. Inside the Austrian Success Story on Solar Water Heaters, *Technology Analysis & Strategic Management*, 13(1): 105-115.
- Ökostromgesetz (2002), Austrian Renewable Electricity Act, Vienna (forthcoming).
- Painuly, J.P. (2001), Barriers to renewable energy penetration: a framework for analysis, *Renewable Energy*, 24(1): 73-89.
- Rennings, K. (2000), Redefining innovation – eco-innovation research and the contribution from ecological economics, *Ecological Economics*, 32(2): 319-332.
- Rogers, E. M. (1995), *Diffusion of Innovations*, 4<sup>th</sup> Ed., New York: The Free Press.
- Roos, A.; Graham, R.L.; Hektor, B.; Rakos, C. (1999), Critical factors to bioenergy implementation, *Biomass and Bioenergy*, 17(2): 113-126.
- Unruh, G.C. (2000), Understanding carbon lock-in, *Energy Policy*, 28(12): 817-830.
- Unruh, G.C. (2002), Escaping carbon lock-in, *Energy Policy*, 30(4): 317-325.
- UNDP/UNDESA/WEC (2000), *World Energy Assessment. Energy and the Challenge of Sustainability*. New York: United Nations Development Programme / United Nations Department of Economic and Social Affairs / World Energy Council.
- Wohlgemuth, N.; Madlener, R. (2000), Financial Support of Renewable Energy Systems: Investment vs. Operating Cost Subsidies, *Proceedings of the NAEE Conference "Towards an Integrated European Energy Market"*, Bergen/Norway, 31 Aug - 2 Sep 2000.

## Session 2: Pros and Cons of various promotion strategies

### A green certificate market for developing renewable energy technologies – pros et cons.

*Poul Erik Morthorst, Risø National Laboratory, Roskilde, Denmark*

**Keywords.** Green certificate market; Renewable energy; Electricity spot market; Greenhouse gas reductions.

**Abstract.** A tradable green certificate (TGC) system is a recently introduced instrument at the energy and environmental policy scene for supporting the development of new renewable technologies. It has within recent years gained much interest in Europe and elsewhere and a number of countries already have or are in the preparation phase of introducing a TGC-system. But between the EU member states opinions differ on the usability of this system, e.g. Germany and France have decided to stick to the well-tried feed-in tariff system for supporting renewable technologies. And although a number of projects have been carried out on the subject, how a TGC-market will function, both on its own and interacting with other policy instruments and markets is still not a trivial matter. This paper tries to survey some of the advantages and disadvantages of the green certificate system.

#### Introduction

Recently renewable energy technologies have gained much interest as some of the more promising options for attaining a sustainable energy development. This is reflected in the EU-Commission's White Paper on a strategy for developing renewable energy technologies where the Commission has launched a goal of covering by renewable energy supplies 12% of the European Union's gross inland energy consumption by 2010. These supplies would be mainly biomass, hydropower, wind energy and solar energy. Next to biomass, wind energy is foreseen to be the main future contributor (European Commission, 1997)<sup>35</sup>. In line with this the European Commission (European Commission, 2000) has launched a directive on the promotion of renewable energy technologies for power production (RES-E). This includes a proposal on the share of RES-E in the individual member states in 2010, based on the percentage of each country's consumption of electricity. Although not binding by now it seems that these targets are accepted by the EU member states.

To reach these targets for RES-E deployment a number of different policy instruments are on hand. Among the highly relevant ones is the establishment of a market for tradable green certificates (TGCs), which within the past few years have gained an extensive interest in Europe and elsewhere. Markets based on green certificates or equivalent instruments are already established a number of places, among these Australia, Holland, England, Italy and Texas. Other countries are

in the preparation phase. Sweden and Belgium (Flanders) are moving fast towards certificate-schemes, while although an early mover the Danish Parliament has postponed the introduction in Denmark until 2004-5. Until now TGC-markets are only established as national ones, but the above-mentioned indicative EU-targets for renewable deployment could be a fine starting point for the development of an international TGC-market, including a number of EU member states.

The TGC-market is a new instrument that has been introduced at the energy and environmental policy scene and how this market will function, both on its own and interacting with other policy instruments and markets is not a trivial matter. Although not aiming at fulfilling all needs, this paper outlines some of the advantages and disadvantages of introducing a tradable green certificate system for supporting the development of new renewable technologies.

#### The green certificate market

In the following the main characteristics of a tradable green certificate system will be described. The description here is partly related to an existing Danish proposal and the TGC-system is expected to be in operation in Denmark in 2004-5. Of course, other designs of TGC-markets than the one described here do exist but their main characteristics are all pretty much in line. For more detailed information on TGCs see (Morthorst, 2000).

At present almost no renewable energy technologies on their own can economically compete with conventional energy producing ones. The idea of a TGC-approach is to use market forces to determine the necessary additional payment to investors in renewable plants. Thus, the payments to owners of renewable plants will consist of two parts: one part from the sale of the electricity produced to the spot market and one from the sale of green certificates. The two parts will be traded at two separate markets and thus the financial certificate market in principle will be totally separated from the physical electricity market.

The Danish proposal is connected to renewable technologies producing electricity (Ministry of Environment and Energy, 1999).

- All consumers of electricity in Denmark are obliged to buy a certain share of electricity generated by renewable energy technologies. A major part of this will be covered by the electricity distribution companies, which will buy the green electricity on behalf of their consumers. Large companies (or other consumers) trading directly with power suppliers will have to cover an equivalent share of their consumption with green electricity
- All renewable energy technologies, including wind power, biomass and biogas plants, photovoltaics, geothermal and small hydro plants, will be certified for producing green electricity. The owners

<sup>35</sup> The 12% target includes large-scale hydro, for which the potential for further exploration in the EU is very limited for environmental reasons.

will get a green certificate per unit of electricity produced (per MWh). This certificate can be sold to distribution companies or other electricity consumers, who will be obliged to cover a certain share of their electricity consumption.

Thus there will be a demand for green certificates by distribution companies and other consumers, who will have to cover their share on an annual basis. The Energy Authorities will determine this share, presumably for a number of years in advance. At the end of each year a volume of TGCs corresponding to the quota will be withdrawn from the market by the authorities (Ministry of Environment and Energy, 1999). Originally a share of 20% of total electricity consumption was to be covered in Denmark by the end of 2003 (for all renewable technologies), but as mentioned above the introduction of the TGC-market is postponed to 2004-5. Supply will be determined by the production of electricity from the above-mentioned renewable energy technologies. In 2001 approx. 16% of electricity production in Denmark was supplied by wind power and 1-2 % by other renewables.

The green certificates will be supplied to the market partly by already existing renewable plants, that is plants established before the time-period considered, and partly by newly established ones. At the core of the certificate market approach is a regulated development of new renewable capacity. Thus it is important that the quota is set in such a way, that after subtracting the supply of certificates by existing renewable plants from the given quota, then it should be possible to cover the residual demand for certificates in the given time-period by newly established capacity. The increases in quotas over time will have significant impacts upon the expected future price of certificates, which are of utmost importance for potential new investors in renewable capacity.

The long run marginal cost of renewable produced electricity is the core in the long run supply of certificates, where the long run marginal cost is defined as the cost per unit of energy produced (per kWh) over the lifetime of the plant, taking into account all the relevant costing issues. Parameters paramount to the decision for establishing a new renewable plant include investment costs, O&M costs, the expected lifetime of the plant and its electricity production and, finally, an appropriate risk premium. The risk premium will to a certain extent depend on technological risk factors as the expected availability of the plant, but most importantly will be economic factors as the expected future development of the long term price for electricity at the spot market and the corresponding price of the green certificates. Thus for potentially new renewable plant owners not only the green certificate market will be relevant, the physical spot market for electricity will be important as well<sup>36</sup>. Price-determination at these two markets is expected to be closely interrelated. The potential wind turbine owners will have expectations to

the *total* price paid for the energy produced, i.e. for the price of electricity at the spot market plus the price per kWh obtained at the green certificate market. Thus if the spot market price is low, this will increase expectations to the price of green certificates, while if the spot price is high a lower price of green certificates might be accepted. At the same time the given quotas will influence the future price of green certificates. If a rapid development of new renewable capacity is stated by the quotas, this will tend to rise the certificate-price – in a similar way a slow development of the quotas will tend to lower the certificate-price.

The determination of the expected long run equilibrium price for the green certificates is shown in Fig. 1 below.

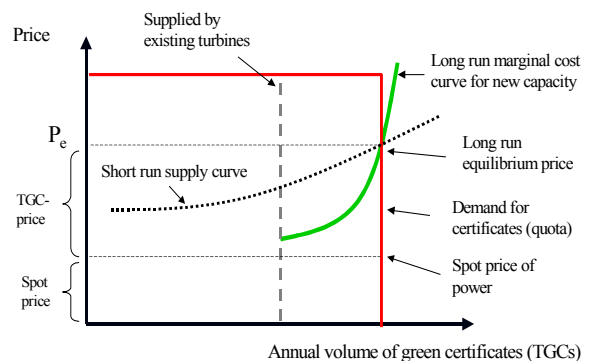


Fig. 1: Price determination and the relation between long and short run in a green certificate market.

The supply from existing renewable plants covers part of the predetermined demand for certificates (the quota) and those plants expected to be established in the previous period has to cover the residual part to fulfil the quota. The expected long run equilibrium price for the development of new renewable capacity ( $P_e$ ) is determined by the intersection of the expected long run marginal cost curve for new capacity and the vertical demand line (the quota). As shown in Fig. 1 this long run equilibrium price is split into a part covered by the spot market price of power and a residual part to be covered by the price of the green certificates.  $P_e$  is the starting point for the short run supply curve. If short-term conditions are in accordance with the expected long-term development, the short run price of certificates will be equal to the long run equilibrium price. But if short and long term conditions differ (e.g. if produced electricity by existing plants falls short of expected production, which will shift the short run supply curve inwards), the short run price of certificates will be different from the one given by the long run equilibrium.<sup>37</sup>

A number of reasons might exist that the long-term equilibrium would not be fulfilled, among these most importantly that the amount of generated electricity would differ from the expected production. In that case the supply of certificates is determined by the short run supply curve, as shown in Fig. 1. The shape and slope

<sup>36</sup> According to the Danish electricity agreement all electricity has to be supplied to a power market, following a transition period this accounts for renewable energy technologies too.

<sup>37</sup> The short run supply curve in Fig. 1 is drawn given the assumption that the validity of certificates is eternal. If the validity is limited to e.g. one year, the curve would look much different.

of this supply curve will be determined by short run considerations, among these the suppliers willingness or aversions to risk, their individual economic situation and expectations to the size of the quota compared to the expected power production. Until now experiences with green certificate markets using the obligatory quota concept are limited and therefore it is difficult a priori to determine the shape of the short run supply curve.

### Advantages related to the introduction of a TGC-system

A number of advantages and disadvantages are related to a TGC-system. In the following two sections some of these will shortly be described.

In this section the pros of the green certificate system will be treated. Among these are the following:

- Efficiency improvements of new renewable energy technologies will directly show up as lower TGC-prices and thus in a lower payment to the owners of renewable plants.
- Compared to the feed-in tariff system a strong regulation of renewable capacity development is ensured. The feed-in system is a fixed price approach, where the market determines the volume (capacity). In the TGC-system this is turn upside down – the market determines the price while the volume is determined a priori. Thus it is much easier in a TGC-system to keep the burden of subsidising renewable technologies within the expected limits.
- In the former Danish feed-in system the Government subsidised the development of renewable technologies. In 1998<sup>38</sup> more than 100 million € was paid out of the public budget to subsidise the development of wind turbines, only. In the TGC-system this burden of subsidising renewables is put on the shoulders of the electricity consumers. Although not a specific characteristic of the TGC-system this was one of the reasons for introducing a green certificate system in Denmark.
- International trade in green certificates is an obvious possibility and therefore a TGC-system will encourage improving the siting of new renewable plants.

Due to the strong connections between improved efficiencies of new renewable plants and the long run TGC-price, the TGC-market should in principle make itself redundant in the long term. To show how this influences the development of the TGC-price over time the results of an illustrative simulation with a TGC-market model is shown in Fig. 2.

The starting point for the simulation is the “no efficiency improvement” case. In this case the simulation is adjusted<sup>39</sup> to follow a path of almost constant TGC-prices – the small ups and downs could be removed by a closer fine-tuning of the model, but has no influence

on the results. Observe that an upper and lower limit of the TGC-price is assumed as in the Danish TGC-approach. If energy production efficiency improvements of new renewable plants are assumed significant reductions in the TGC-prices show up as the result. An annual efficiency increase of 2% for new plants would as a result imply that the TGC-price would hit the lower limit after approx. 20 years<sup>40</sup>. If an efficiency improvement of 1% p.a. is combined with a 1% p.a. decrease in investment cost, the results would be slightly more positive, because investment costs are reduced up-front. In Denmark wind power is the dominant renewable technology and for a number of years the production efficiency has increased by 3-4% annually. If this is to continue in the future wind power will need the support from the green certificate market for a fairly short number of years, only.

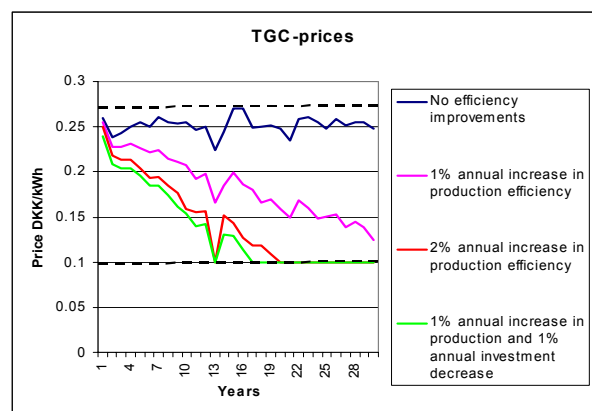


Fig. 2: Simulating TGC-price developments in cases with different technological development (different efficiency improvements) assuming an upper and a lower price limit.

An important feature of the TGC-approach is the possibility of international trade in certificates. This will ensure a cost-effective siting of renewables and their development. The renewable technologies will be established in countries with the highest production potentials and where renewable energy can be produced at the least cost. Problems in fulfilling the national quotas will be handled by importing TGCs, while the surplus of certificates may be exported to countries with a shortage. This ensures that the national targets to develop renewable energy technologies are reached in the most cost-efficient way.

The advantages of international trade in certificates are illustrated in Fig. 3 below.

Two countries are illustrated in Fig. 3: country A and country B. For each country a quota for the development of renewables is specified as shown in Fig. 3. According to the marginal production costs of developing new renewable capacity in the two countries, country A should develop its domestic renewables until point  $MCRP_A$ , where the quota is covered, and correspondingly country B until point  $MCRP_B$ . But economically both countries would benefit from develop-

<sup>38</sup> The feed-in system was brought to an end in 1999 in Denmark.

<sup>39</sup> By adjusting the TGC-quota.

<sup>40</sup> Assuming that no other barriers would restrict the renewable development.

ing the renewables until point  $MCRP_T$ , a lower development for country A and a higher for country B. Thus the national quotas for renewable development in both countries would be fulfilled by country B exporting T units of green certificates to country A.

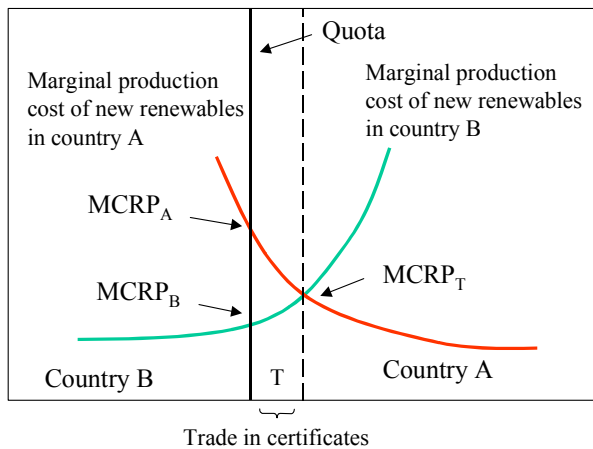


Fig. 3: International trade in green certificates

Of course, efficiency in siting new renewable plants will be achieved within the borders of an individual country as well, but the larger an area covered the more renewable development will benefit of a TGC-system.

### Disadvantages related to the introduction of a TGC-system

Unfortunately a number of disadvantages are related to the introduction of a green certificate system as well. Among these can be mentioned:

- Only the most economic competitive renewable technology is promoted by the TGC-system.
- To be efficient the national TGC-market should have a certain minimum volume. In Denmark it worries that the Danish TGC-market would be fairly small especially in the transition phase, although no thorough analysis are carried out on this subject by now.
- Assuming as usual that no CO<sub>2</sub>-credits are attached to the green certificates then an international TGC-market will not fit well into an international liberalised power market set-up. Those countries most ambitious in setting high TGC-quotas will have to buy certificates from the less ambitious ones, although this only contributes to fulfilling a national target for renewable development, not in reaching their national CO<sub>2</sub>-reduction targets.

That only the most economic attractive renewable technologies are supported by the green certificate system is illustrated in Fig. 4 below for two renewable technologies – wind power and photovoltaics – assuming that wind power is more economic competitive than photovoltaics. Observe that an upper and lower limit of the TGC-price is assumed in the figure.

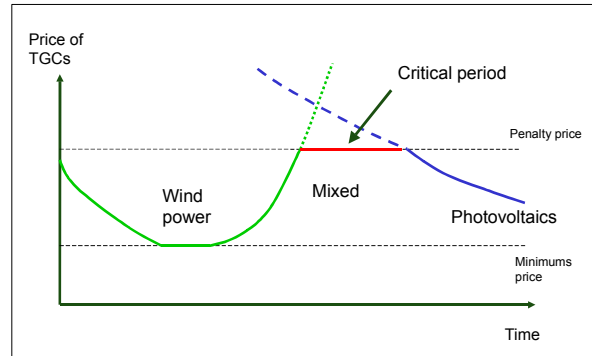


Fig. 4: The TGC-market will only promote the most economic competitive technology.

Within the support range given by the TGC-system wind power is the most profitable of the available renewable technologies and during a certain time-period competition among wind projects equipped with still more efficient new turbines drive down the price of TGCs<sup>41</sup>. But at a point of time the limited number of available efficient sites increases the price of wind power again<sup>42</sup>, although wind power technology is still improving. The critical period shows up when almost all just reasonable profitable sites for wind turbines are utilised, but no new renewable technology is prepared to take over. Thus the TGC-system does not handle the development of new technologies in a broad sense. Alongside the introduction of a TGC-market specific support mechanisms for developing new non-profitable technologies are still needed.

The reduction of greenhouse gas emissions is an important goal in the energy and environmental policies of the European Union and its member states. And according to the above-mentioned recent directive-proposal from the EU commission, the inclusion of renewable technologies is one of the important ways to achieve this emission reduction. But how the TGC-system interacts with other GHG-reducing policy instruments is not a trivial matter. In the following the results of a three-country model assuming an international liberalised power market and a common TGC-market for these countries will be used to illustrate how the two markets interact and how these markets will behave in relation to reaching national GHG reduction targets. Due to limited space only results are reported here – details are found in [Morthorst, 2002].

The starting point for the analysis is a pre-TGC situation, where all three countries previously have engaged in the development of renewable technologies, but no TGC-market yet exists. This starting point is shown as the left column in Table 3, below.

As shown in Table 3 all three countries previously have a renewable power production, which together with conventional fossil fuel based power production is expected to cover the total demand for power in the region. Country C has the highest production of renewable power (6.0 TWh), while country A has the lowest production of 4.0 TWh.

<sup>41</sup> Assuming a constant spot market price for power.

<sup>42</sup> Or wind power development is stopped because no new sites are available.



Table 3. Introducing a TGC-market separately into a liberalised power market.

Country	Pre-TGC	Introducing a TGC-market		
	Renewable power production	Ren. Quota Increase in ren. power	Increase in actual ren. production	Achieved CO <sub>2</sub> reduction
	TWh	TWh	TWh	MT/a
A	4.0	0.2	0.9	0.9
B	5.0	0.3	0.8	0.7
C	6.0	2.2	1.0	0.8
Total	15	2.7	2.7	2.4

Now, in common the three countries introduce an international tradable green certificate market, assigning quotas to the domestic use of renewable power. Thus, as shown in Table 3 country C is most ambitious in its target setting for renewable development. Compared with the other countries the development of renewables is assumed to be fairly cheap in country C and therefore it increases its amount of renewable power by 2.2 TWh (36%) to an expected total of 8.2 TWh. The two other countries are less ambitious increasing their renewable target by 5% and 6%, respectively. The increase in TGC-quotas in the three countries signals a total increase in the amount of renewable produced electricity of 2.7 TWh or 18%.

Now, in a TGC-market the total increase in renewable production is distributed across the three countries according to the marginal cost conditions of developing new renewable capacity. Assuming that the TGC-quotas are fulfilled<sup>43</sup> the introduction of the TGC-market increases the renewable power production by 2.7 TWh. Although country C has increased its target by 2.2 TWh only 1.0 TWh is developed domestically. Although the development of renewables is fairly cheap in country C the residual part is more cost-efficient developed in the other countries. Thus, country C will not reach its renewable target by domestic supplies alone, but will have to import certificates corresponding to 1.2 TWh (cf. Table 3). The fact that the most ambitious country cannot expect to fulfil its quota only by domestic renewable development is perfectly in accordance with the idea of an international TGC-market.

What happens at the spot market is illustrated in Fig. 5. The supply of power from each of the three countries is shown at the horizontal axes, while the price is shown at the vertical axes. The increase in renewable power production shifts the supply curves for the three countries to the right – due to the low marginal cost of renewable production more power can now be supplied at the same price ( $P_1$ ). Because the need for power in the three countries has not changed the surplus of power depresses the price at the spot market and a new equilibrium equalising supply with demand is found at a lower price ( $P_2$ ). In this situation the conventional power production<sup>44</sup> has decreased in all three countries; in total by the amount of 2.7 TWh, which was the increase in renewable power production.

<sup>43</sup> Short-term considerations are not taken into account.

<sup>44</sup> The conventional power is decreased because it is the most expensive power at the spot market.

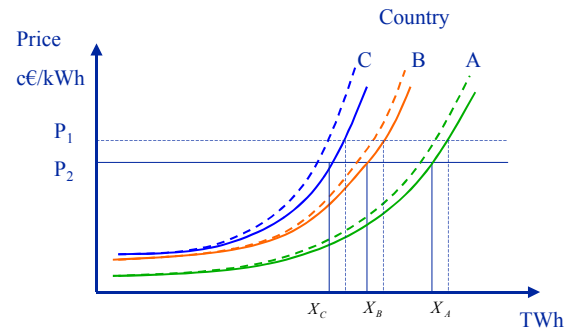


Fig. 5: The consequences at the spot market of introducing the TGC-market

Thus due to market conditions the strong increase in the TGC-quota for renewable production in country C has as its implication a lower conventional power production in all three countries. Observe that only the total increase in renewable production together with the marginal cost conditions at the spot market determines how the substitution of conventional power is split upon the three countries. How the total increase in renewable power production by itself is distributed upon the countries has no influence upon the realised substitution of conventional power, which depends totally on the marginal cost conditions at the spot market.

When conventional power is replaced by renewable energy emissions of CO<sub>2</sub> are reduced. The emission-reduction achieved will depend on the emission-coefficients related to the replaced conventional power. As shown in Table 3 a total CO<sub>2</sub>-reduction of 2.4 MT is achieved, almost equally distributed upon the three countries. When emissions are related to the production of conventional power, the same observation as for the substituted power goes for CO<sub>2</sub>-reductions: How the total increase in renewable power production by itself is distributed upon the countries has no influence upon the realised CO<sub>2</sub>-reduction in each of the countries. This is totally determined by the marginal cost conditions at the spot market and the marginal emission-coefficients of the substituted power.

Thus, the main result of the ambitious renewable target setting in country C is that they have to share the achieved CO<sub>2</sub>-reduction with the less ambitious countries, as shown in Table 3. In addition country C will have to pay an extra cost for importing that part of the TGC-quota, that is not fulfilled by their own domestically produced renewable power. This cost is only related to achieving a national target for renewable development, while no additional national CO<sub>2</sub>-reduction is gained.

Thus, a separate introduction of an international green certificate system into a liberalised electricity market cannot be recommended, if the TGC-market is expected to contribute to achieving the national CO<sub>2</sub>-reduction targets. But of course the development of renewable sources in general does contribute to overall European greenhouse gas reductions.

The problem of renewable development not contributing in full in reaching a national GHG-reduction target is not limited to the use of a TGC-system. Actually the problem is exactly the same in an ordinary

planning system or in an approach based on feed-in tariffs. The problem is caused by the fact that a national emission reduction target does not go well together with a liberalised power market. Thus a general remedy has to be found. One solution is to introduce a tradable permits scheme as the one recently suggested by the European Commission. Therefore, it could be relevant to have a closer look at a combination of an international green certificate market and a tradable permits market introduced into a liberalised power market<sup>45</sup>.

How the tradable permits scheme works in relation to a TGC-market is illustrated in Fig. 6 below.

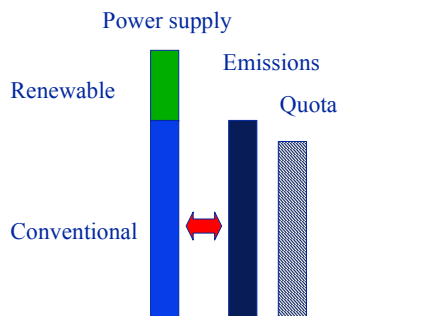


Fig. 6: The functioning of a tradable permits scheme in relation to a TGC-market.

The total power supply is split into two parts: A conventional part, based on fossil fuel fired plants, and a renewable part covered by the TGC-market. The emission of CO<sub>2</sub> corresponds closely to the conventional produced power (cf. Fig. 6).

The tradable permit (TEP) quota is introduced to lower emissions from the conventional power industry and for that reason the quota assigns a lower volume of emissions than previously experienced. The CO<sub>2</sub>-reductions are carried out where it is least costly and trade in permits will ensure a cost-effective utilisation of CO<sub>2</sub>-reducing options within the power industry. What is important for the combined system of TGCs and TEPs is a close co-ordination of the use of these two instruments. The importance of this with regard to achieving CO<sub>2</sub> reductions is illustrated in Fig. 7 below.

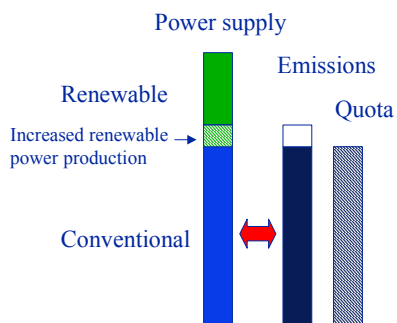


Fig. 7: A non co-ordinated development of the TGC-market in relation to the tradable permits market.

In Fig. 7 are shown the consequences of an non-coordinated increase in the renewable power production

undertaken by an increased quota for renewable capacity. Renewable power production takes on a higher share of total power supply, thereby decreasing conventional power production. As the quota for tradable permits is kept at the previous level, this eases the situation for the conventional power industry: The TEP-quotas assign allowable emissions in relation to an expected level of power production. The increase in power production from renewables substitutes conventional power production and although the power industry has to produce less electricity, the emission quotas are unchanged. Thus, compared to the needed power relatively less CO<sub>2</sub>-reductions are required in the power industry.

Thus when a TEP-quota is determined it has to take into account *both* the CO<sub>2</sub>-reduction possibilities *and* the required level of electricity production, thus the TGC- and TEP-quotas should be adjusted in a co-ordinated manner. Otherwise the full value of the expected CO<sub>2</sub>-reductions will not be achieved. When the green power production is increased, the TEP-quota should be decreased correspondingly. Although this of course requires a strong co-ordination of policies it is a possible way to use the two instruments in combination in contributing to achieving national greenhouse gas reduction targets.

## Conclusions

A TGC-scheme could be a relevant policy instrument for promoting the development of new renewable technologies. The advantages in introducing a TGC-system include a cost-efficient development of renewable technologies because improved production efficiency is directly reflected in the TGC-price. Moreover an efficient siting of the renewable plants are undertaken, especially if an international TGC-market is established.

Unfortunately the TGC-system does not handle all issues of relevance regarding the development of new renewable technologies. In a TGC-scheme only the most economic competitive renewable technology is supported, thus alongside the introduction of a TGC-market specific support mechanisms for developing new non-profitable technologies are still needed.

Finally, the development of renewables is foreseen – both by the member states and by the European Commission – to play an important role in the reduction of greenhouse gas emissions. A main conclusion from this paper is that a separate introduction of an international green certificate system into a liberalised electricity market cannot be recommended, if the TGC-market is expected to contribute to achieving the national CO<sub>2</sub>-reduction targets:

- Countries most ambitious in renewable target setting by increasing their TGC-quotas will only partly be gaining the CO<sub>2</sub>-reduction benefits themselves. How much they gain will totally be determined by the marginal conditions at the spot markets and the emission-coefficients of the replaced power. Thus, the ambitious countries support the less ambitious ones in achieving their GHG-reduction targets.

<sup>45</sup> More details on this combined market set-up are given in (Morthorst, 2003).



- To fulfil their TGC-quotas the most ambitious countries will have to buy certificates from the less ambitious ones, although this only contributes to fulfilling a national target for renewable development, not in reaching their national CO<sub>2</sub>-reduction targets.

A remedy to this problem is found by introducing a combined system of a green certificate and a tradable permits market. This requires that the quotas of the two markets be adjusted in a co-ordinated manner: When the green power production is increased, the tradable permits quota should be decreased correspondingly. Otherwise the expected CO<sub>2</sub>-reductions will not contribute by the full value in achieving the national targets for greenhouse gas reductions. Although this requires a strong co-ordination of these policy instruments it might show the necessary way forward if renewable technologies are to contribute significantly in achieving the national emission reduction targets.

Finally, it should be pointed out, that the problem of gaining the full benefit of a national implementation of renewable power is not only related to green certificate markets, but is general in character if the country takes part in a liberalised power market. Those countries most ambitious in implementing renewables sources might see part of the expected CO<sub>2</sub> benefit disappearing to other less ambitious countries participating in the same power market. If the necessary co-ordination of measures is undertaken the introduction of a tradable permits scheme may be the solution in these cases as well.

## References

- European Commission, 1997: Energy for the future: Renewable sources of energy. (White Paper, 26/11/97).
- European Commission, 2000: Proposal for a directive of the European parliament and of the council on the promotion of electricity from renewable energy sources in the internal electricity market.
- Morthorst, P.E., 2000: The development of a green certificate market. *Energy Policy*, November 2000, vol. 28/15, p. 1085-1094.
- Ministry of Environment and Energy, 1999b: Elreformen (The Danish electricity reform (in Danish)), (March 1999).
- Morthorst, P.E., 2001: Interactions of a tradable green certificate market with a tradable permits market. *Energy Policy*, February 2001, vol. 29/5, p. 345-353.
- Morthorst, P.E., 2002: A green certificate market combined with a liberalised power market, *forthcoming in Energy Policy*.
- Morthorst, P.E., 2003: National environmental targets and international emission reduction instruments. *Energy Policy*, January 2003, vol. 31/1, p. 73-83.

## Feed-in tariffs versus quotas: how to promote renewables and stimulate technical progress for cost decrease ?

*Philippe Menanteau, Dominique Finon, Marie-Laure Lamy, IEPE, CNRS / Université Pierre Mendès-France, Grenoble, France*

**Keywords:** innovation, renewable energy, public policy, incentives, prices, quotas.

**Abstract:** Incentive schemes for the development of renewable energy sources may focus on quantities – defining national targets and setting up bidding systems, or quota systems providing for green certificate trading – or they may focus on prices – feed-in tariffs. Whatever the system chosen, the role of the public authorities is quite specific: to stimulate technical progress and speed up the technological learning processes so that ultimately renewable energy technologies will be able to compete with conventional technologies, once the environmental costs have been internalised. A comparison of instruments must thus take into account the characteristics of the innovation process and adoption conditions – uncertainties regarding cost curves, learning effects – which means also looking at dynamic efficiency criteria. The paper concludes that a system of feed-in tariffs is more efficient than a bidding system, but highlights the theoretical interest of green certificate trading which must be confirmed through practice, given the influence of market structures and rules on the performance of this type of approach.

## Introduction

Renewable energies sources (RES) are receiving increasing support from public authorities because of the environmental advantages they procure in comparison with conventional energy sources, particularly for controlling greenhouse gas emissions. With confirmation of the risk of climate change (IPCC, 2000), incentives to develop RES have been reinforced so that the greenhouse gas emissions reduction targets agreed to in the Kyoto Protocol can be achieved. The recent European Directive on renewable energies (EC, 2001), is an illustration of the new ambitious objectives assigned to RES.

The possibility of achieving the targets at a lower cost, which has until now been a relatively secondary concern given that the objectives were limited, has now become a central issue, making it necessary to examine the efficiency of the instruments used to promote RES.

These incentives frameworks are based typically on the same approaches as environmental policies: price-based approaches for systems where electric utilities are obliged to purchase electricity from green power generators at feed-in tariffs, quantity-based approaches where the public authorities set an objective to be reached and organise competitive bidding processes, or where they impose quotas on electricity suppliers and set up a system of tradable green certificates.

Our analysis will focus on renewable energy technologies used to generate electricity for the grid (RES-E). Several electricity generation technologies are potentially concerned: micro-hydro, wind, bioelectricity, photovoltaic solar, etc. These technologies have

reached different stages of maturity, and the type of support given to each must therefore be adapted (Christiansen, 2001). This paper examines only those policies designed to assist entry on the market of technologies that are nearly competitive with conventional technologies, such as biomass technologies and wind energy. The example of wind energy development will be used as the main reference for the analysis.

### Choice of instruments to foster the development of RES-E

An examination of the policies used in the European countries over the last twenty years to promote the development of RES-E shows that the instruments used are very similar to environmental policy instruments. They are all concerned with the question of efficiency in the prices versus quantities debate.

#### *Price-based or quantity-based approach:*

In addition to research and development (R&D), support schemes fall into three main categories that are either price-based or quantity-based in their approach: feed-in tariffs, which constitute the oldest and most widely used support system; bidding processes based on a fixed amount of renewable energy to be generated nationally and tradable green certificates schemes, where electricity suppliers are obliged to produce or distribute a certain quota of renewable energy.

### Feed-in tariffs

The feed-in tariff scheme involves an obligation on the part of electric utilities to purchase the electricity produced by renewable energy producers in their service area at a tariff determined by the public authorities and guaranteed for a specified period of time (generally about 15 years).

The feed-in tariff system operates as a subsidy allocated to producers of renewable electricity. It works in the same way as a pollution tax does for firms that pollute. Take the example of wind energy: producers are encouraged to exploit all available generating sites until the marginal cost of producing wind power equalises the proposed feed-in tariff  $P_{in}$ . The amount generated then corresponds to  $Q_{out}$  (Fig. 1).  $Q_{out}$  is not known a priori if the marginal cost curve for wind energy generation is not known, which is generally the case.

All projects of course benefit from the tariff  $P_{in}$ , including those whose marginal production costs are considerably lower than the proposed tariff. The difference in quality of the various sites leads to the attribution of a differential rent, to the advantage of those projects which have the lowest production costs. The overall cost of reaching the objective is given by the area  $P_{in} \times Q_{out}$ .

The cost of subsidising producers of RES-E is covered either through cross-subsidies among all electricity consumers (Spain, Italy) or simply by those customers of the utility obliged to buy green electricity (Germany until 2000), or by the taxpayer, or a combi-

nation of both systems (Denmark)<sup>46</sup>. Calling simply on customers of local companies to finance green power generation is considered unfair and mechanisms are therefore often adopted to share the burden more equitably (cf. *infra*).

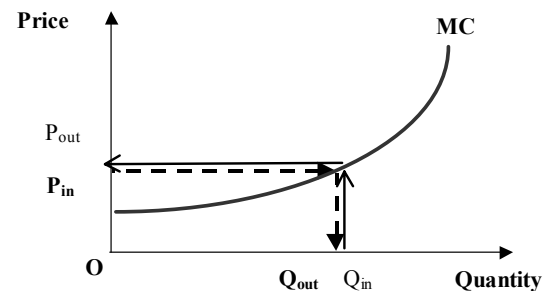


Fig. 1. Prices vs quantity-based approach

### Competitive bidding processes

In the case of competitive bidding processes, the regulator defines a reserved market for a given amount of RES-E and organises a competition between renewable producers to allocate this amount. Electric utilities are then obliged to purchase the electricity from the selected power producers<sup>47</sup>.

Competition focuses on the price per kWh proposed during the bidding process. Proposals are classified in increasing order of cost until the amount to be contracted is reached. Each of the renewable energy generators selected is awarded a long term contract to supply electricity at the pay-as-bid price. The marginal cost  $P_{out}$  is the price paid for the last project selected which enables the quantity  $Q_{in}$  to be reached (Fig 1). The implicit subsidies attributed to each generator correspond to the difference between the bid price and the wholesale market price.

The competitive bidding procedure enables the marginal production costs of all the producers to be identified (ex post). The overall cost of reaching the target is given by the area situated under the marginal cost curve. The differential rent which, in a system of feed-in tariffs, is paid to renewable energy generators, does not in this case have to be borne by consumers.

Another difference between competitive bidding and feed-in tariffs is that the exact amount of renewable electricity concerned by the bids is in this case a priori known. On the other hand, since the precise shape of the cost curve is not known (ex ante), the marginal cost and the overall cost of reaching the target cannot be determined.

Finally, the extra cost is financed in much the same way as in the previous case. It is either added to electricity bills in the form of a special levy (England), or

<sup>46</sup> In Germany, the new tariffs for wind energy are 0.091 €/kWh during 5 years, after which the rate decreases depending on the site; in Denmark, the tariff is fixed at 85% of the domestic tariff supplemented by the reimbursement of the carbon tax.

<sup>47</sup> Competitive bidding systems have been used in the United Kingdom under the Non-Fossil Fuel Obligation (NFFO) set up in 1991 and which concerned different renewable energy technologies. Similar schemes existed in France with the Eole 2005 program set up in 1996 to promote wind energy.

the cost is covered through cross-subsidisation among all electricity consumers (France).

### Green certificates

In this type of scheme, a fixed quota of the electricity sold by operators on the market has to be generated from RES. Liable entities then have the possibility of generating the required amount of electricity themselves, purchasing through long term contracts from a specialised renewable energy producer, or purchasing certificates for specific amounts of green electricity from other operators (Berry, T. et al, 2001; Voogt, M. et al. 2000).

The amount of green electricity to be generated is decided for the whole country, as in the case of bidding schemes, and is then divided among each of the operators (consumer, retailer, distributor or producer). Since operators do not all benefit from the same opportunities to develop renewable energy sources and thus have different marginal production cost curves, green certificates enable quotas to be allocated in an efficient way. Without such a flexibility mechanism, operators with identical obligations would incur different marginal costs, which would be a source of inefficiency. With a certificates system, the burden is shared efficiently: marginal production costs are equalised among operators and specialised producers are encouraged to enter the market.

As a result, the global target  $Q_{in}$  attributed to the operators is reached at the market price of the certificates  $P_{out}$ . Clearly the same results could be achieved without flexibility mechanisms by assigning different objectives to each operator. But, in a situation where the public authority - and probably also the operators themselves - have only incomplete information, it is very difficult to allocate efficient quantities which would equalise marginal costs. Under the green certificate system, specific objectives ( $Q_A$ ,  $Q_B$ , etc.) can be assigned to all the operators while at the same time minimising the overall cost of reaching the production target through equalisation of the marginal production costs.

### *Asymmetry of price-based/quantity-based approaches in situation with imperfect information*

In the case of pollution control methods, when all the necessary information is available, price-based and quantity-based schemes produce very similar results. The administrative authority can fix the "price" in the case of the tax, or the "quantity" in the case of permits, so as to reach the same pollution control target.

Price-based and quantity-based approaches are not equivalent in situation where information is incomplete (uncertainty). When the depollution cost curves are not known, the tax provides a certain control over the cost of measures to be used. However, it will not a priori provide an indication of the amount of pollution avoided, nor therefore of the overall cost of the pollution control measure.

Similarly, a quantity-based approach will not enable the total cost of pollution control to be estimated since the marginal cost of the technical options to be used is not known. However, a quantity-based approach en-

sures direct control over the authorised amounts of pollution.

In situation of incomplete information, the symmetry between the price-based and quantity-based approaches is not total. It is thus understandable that incentives based on feed-in tariffs have been criticised for their excessively high overall cost. If it is assumed that the wind energy cost curves are, at the present stage, relatively flat<sup>48</sup> it can be seen that a slight variation in the feed-in tariff proposed leads to substantial increase in the quantities produced from  $Q_1$  to  $Q_2$  (Fig.2), and consequently in subsidies, whether financed by electricity consumers or the public budget. On the other hand, this risk has been limited by quantity-based schemes, since successive tendering procedures have made it possible to maintain indirect control over prices and to anticipate the level of subsidies.

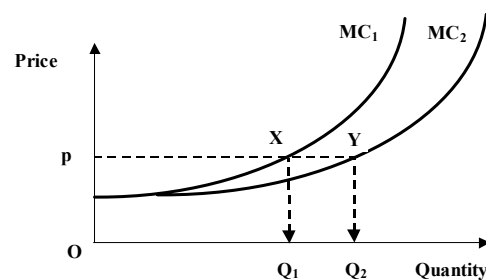


Fig. 2. Price-based approach in a situation of uncertainty

### *Differences in dynamic efficiency: the impact on technical change*

The question of encouraging technical progress involves two different problems. The first concerns cost reductions resulting from the pressure of competition between projects, based on the portfolio of available technologies. The second concerns the effort devoted to seeking technological innovations made possible by new R&D investments financed by the surplus obtained from selling RES electricity.

In the first case, the pressure to reduce costs is encountered only in the case of competitive bidding and green certificates, investors being price-takers in order to anticipate the profitability of their projects. The system of feed-in tariffs does not provide the same kind of incentive. The dynamic effect must also be assessed in relation to the installed capacities (technological learning). In this respect, competitive bidding systems are limited in their effects since their performance in terms of installation is poor in comparison with the feed-in tariff system (cf. infra).

In the second case, the basic premise is that once producers and their equipment suppliers attain a certain level of profit, they invest in R&D in order to lower costs and increase their profit. We must therefore look at the surplus resulting from technical change and how it is shared out between producers and consumers (or taxpayers) depending on the type of incentive used,

<sup>48</sup> The precise shape of the cost curves is not known. Intuitively, it can be assumed that these curves are relatively flat for a given technology, since the best sites (coastal areas) have so far hardly been exploited.

feed-in tariffs, competitive bidding or green certificates.

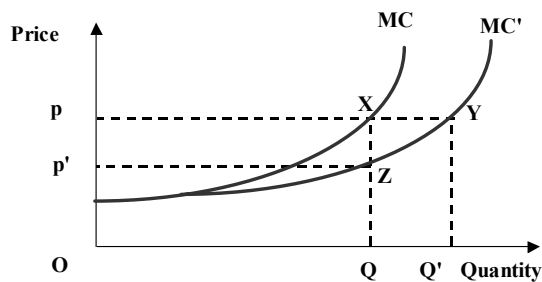


Fig. 3. Feed-in tariffs and technical change

In the case of a guaranteed price level  $p$ , when technical change is included in the calculation, production costs are reduced from  $MC$  to  $MC'$ , and renewable energy generation is increased from  $Q$  to  $Q'$  (Fig. 3). With such a hypothesis, where prices remain constant, the community benefits from the increased generation of RES-E and producers keep the surplus created by technical change (area  $O'XY$ ).

In a bidding system, if we take the same amount  $Q$  and include technical change, we get the equilibrium point  $Z$ . If prices are attributed according to the "pay as bid" price, the surplus  $O'XZ$  resulting from technical progress goes to the consumer, or to the taxpayer. In the case of a green certificates scheme, for an amount  $Q$ , the equilibrium price will be established at  $p'$ . Some of the surplus will go to the producers ( $O'Zp'$ ) but compared to the previous situation it will be reduced by the area  $pXZp'$ .

The three instruments produce different results in terms of how the surplus is shared. In the case of feed-in tariffs, technical change tends to increase the producers' surplus, thus encouraging them to innovate. Inversely, with quantity-based approaches, the surplus that goes to the producers is limited (as in the case of green certificates), or it may be attributed entirely to consumers ("pay-as-bid" price). Producers are therefore not encouraged to innovate by the prospect of an increased surplus. However, they are compelled to remain competitive and so must try to benefit from technical progress because of the pressures of bidding processes and the certificates market. In an open economy, this situation may encourage them to turn to foreign technology.

### The comparative efficiency of the different incentive schemes

A number of renewable energy technologies have benefited to varying degrees from support of incentive programs introduced in the industrialised countries over the last 20 years. The impact of these instruments has been particularly felt in the case of wind energy, which is now nearly competitive with conventional technologies. The example of wind energy is therefore used here for reference purposes.

Since 1990, the two main incentives used in the European countries to support the development of wind energy have been feed-in tariffs and competitive bidding systems, which have given very different results.

The impact of these policies will be analysed according to different criteria:

- capacity to stimulate renewable electricity generation
- net overall cost for the community
- incentives to reduce costs and prices
- incentives to innovate.

Green certificate systems are difficult to analyse at this stage on the basis of these criteria because of the limited experience acquired. On the other hand, we shall examine their potential effectiveness in an international market, as part of a joint effort by several countries to combat climate change. This will be the case for the European Member States, which have been assigned individual renewable energy generation targets within the framework of the new European Directive on RES-E.

### Feed-in tariffs and bidding systems

In the following analysis, reference will be made to the four criteria mentioned above.

### Stimulation of RES-E generation: incentives to enter the market

The two systems exhibit radically different market entry incentives in terms of future profitability, risks and transaction costs. The feed-in tariffs in operation in Germany, Denmark and Spain have led to sustained development of wind power, both in terms of installed capacity and at the industrial level (Chabot, 2000; Gutermuth, 2000; Wagner, 2000). Thus, these three countries alone accounted for over 80% of additional installed capacity in Europe in 2000 (cf. Table 1).

The prospect of obtaining a good return on investment offered by relatively high prices levels is the main explanation for the efficiency of this system. The success of the incentive scheme can also be explained by the low risk run by project developers, since subsidies are granted to all new projects and continue throughout the pay off period<sup>49</sup>. At this point, the market risk is non-existent and the profitability of projects depends essentially on the ability of investors to control their costs. Finally, the transaction costs (project preparation, selection procedure) are lower than for the other system, which is laborious and costly to implement. To add impetus to wind power development, France has recently opted for the feed-in tariff system, just a few years after its not totally convincing introduction of a programme based on tendering procedures (Eole 2005).

<sup>49</sup> Under new German legislation, purchase prices are indexed to the wholesale price of electricity and thus likely to change for new arrivals, but they are fixed once and for all for completed projects. Previously, feed-in tariffs were those for the current year with no guarantee for the long term.

Table 1: installed wind power capacity in Europe (MW)

Incentives	Country	Installed cap (end 2000)	Add. cap. (in 2000)
Feed-in tariffs	Germany	6113	1668
	Spain	2402	872
	Denmark	2297	555
	<b>TOTAL</b>	<b>10812</b>	<b>3095</b>
Bidding systems	UK	409	53
	Ireland	118	45
	France	79	56
	<b>TOTAL</b>	<b>606</b>	<b>154</b>

Source: *WindPower Monthly*, The Windindicator  
(<http://www.wpm.co.nz>), April 2002

The considerably lower purchase prices obtained through bidding systems under the pressure of competition limit the margins with respect to risk and thus result in much more limited installed capacities (cf. Table 2). The substantial difference in results between bidding systems and feed-in tariffs might also be explained by the relatively flat cost curves for wind power in the present phase, a virtual doubling of the marginal cost leading to a significant increase in associated capacities.

Table 2: Comparison of wind power prices in Europe in 1998 (in €/kWh)

Feed-in tariffs		
Germany	Denmark	Spain
0.086	0.079	0.068
Average bidding prices		
UK	France	
0.041	0.048	

Source: EC; 1999; NFFO; Eole 2005.

The second factor affecting the attraction of bidding systems is the uncertainty regarding the profitability of submitted projects, for which considerable preparation costs are incurred. The allocation of subsidies after a competitive tendering procedure introduces an element of uncertainty and a new risk<sup>50</sup>, with the unsuccessful bidders remaining fully responsible for the costs of preparing their proposals. Furthermore, the very nature of the bidding system means that profit margins are considerably reduced and expected profitability rates significantly lower than those associated with fixed tariffs. The balance between the risks involved and expected profits is thus clearly to the disadvantage of competitive bidding, making it a less attractive system for investors.

A final factor will influence the feasibility of projects proposed in the context of a bidding system. Certain aspects (environmental impact studies, information programs and public interest, site integration ...), which might appear less important, are given less at-

tention in the project preparation phase. Consequently, in certain regions there may be a strong opposition movement (Brunt, 1998). In comparison, the acceptability of projects is much higher in countries that have feed-in tariffs. In this case, the better profitability conditions offered make it possible to avoid a concentration of projects at the most efficient sites, or the creation of excessively large and controversial wind farms. In this type of incentive system, public preferences can be taken into account through an implicit internalisation of visual externalities. Projects are then more evenly distributed throughout the country. The absence of competition between projects and more favourable purchase prices are factors that have contributed to more geographically balanced development which raises less opposition at the local level.

### Overall cost of supporting renewables

Feed-in tariffs are extremely simple to implement from an administrative point of view. However, they have proved very costly in terms of subsidies, either for clients of electricity utilities or for the State budget, this being the price to pay for the positive impact on the generation of renewable energy. In 1998, the Danish government paid out over 100 million € in subsidies and this figure was expected to rise still further with the increase in generation capacity, creating an increasingly heavy burden on the public budget (Morthorst, 1999). This type of support policy also requires very high cross-subsidies, estimated at around 200 million € in Germany in 2000.

A big advantage of bidding systems is that the level of subsidies for renewable electricity generation can be controlled. In this respect, quantity-based approaches have enabled authorities to maintain greater control over public spending through the organisation of successive tendering procedure, progressively revealing the shape of the cost curve. A comparable result could have been obtained with feed-in tariffs, but the system was institutionally rigid, making it impossible to control through the adjustment of feed-in tariffs.

The feed-in tariffs versus competitive bidding debate has forced the former system to make adaptations to take into account overall cost of public support. Feed-in tariffs decreasing in stage with the level of production have been introduced in order to limit the surplus to the producers at generating sites of high quality. These incremental feed-in tariffs ensure a minimum rate of return to producers at generating sites of lower quality while at the same time controlling the rent allowed to producers who benefit from more favourable conditions (Elgreen, 2001). Germany, and more recently France, have now incorporated this device into their support policy.

### Incentives to reduce costs and prices

Insufficient incentives to lower costs is considered to be the principal weakness of feed-in tariffs, while competitive bidding systems have proved to be particularly effective in this respect (Mitchell, 1995; Mitchell, 2000).

The successive tendering procedures under the NFFO (Non-Fossil Fuel Obligation) resulted in regular

<sup>50</sup> Under NFFO-5, 408 bids were examined, of which 147 were refused.

decreases in the prices awarded to successful bids. The average price for proposals, irrespective of the technology involved, went from 6.7 c€/kWh under NFFO-3 (1994) to 4.2 c€/kWh under NFFO-5 (1998). This price was only 0.15 c€/kWh above the pool reference purchase price for the corresponding period (Kühn et al, 1999). This price reduction bears witness to the capacity of bidding schemes to enable consumers to benefit from all the opportunities to cut production costs.

At the same time, referring to the theory of interest groups, feed-in tariff systems are much less flexible and revisable than bidding schemes when it comes to limiting rents. There is a fundamental political problem in announcing a drop in government support renewable energy. The decrease in investment costs and the improved performance of certain renewable energy technologies, and wind energy in particular, are only partially reflected in the lower feed-in tariffs observed in Germany. This relative price stability results paradoxically in an increase in the share of subsidies allocated to new projects that benefit from technical progress<sup>51</sup>. To overcome this problem, price reductions must be announced ahead of time, when the device is put in place. With degressive feed-in tariffs that anticipate technical progress, the profits resulting from technical progress can be shared out more equitably by reducing the total cost borne by the community while granting a certain surplus to producers (Elgreen, 2001).

While competitive bidding systems undeniably create greater incentive to lower prices and costs of renewable energies, it should be noted that the price reductions observed are not necessarily related solely to technical change (falling investment costs, improved technical performance, learning experience of operators, search of scale effects...) or to its side effects (fall in cost of credit associated with a different perception of the technological risks, for example) but also to a systematic effort to reduce costs through economies of scale and use of the very best sites available.

### Incentives to innovate

The criterion of the dynamic efficiency of the incentive instruments enables the approach to be extended beyond examining simply the effects of reduced costs over a short period. Consideration can also be given to the possibility of establishing sustainable technical progress. The establishment of such a dynamic process depends in part on the technological learning processes related to the wider diffusion of the technologies, but also on manufacturers' R&D investments and thus on the surpluses that they might be allocated.

Feed-in tariffs and pay-as-bid tendering schemes differ in terms of how the surplus resulting from technical change is shared out. In the first case, it is producers-investors and manufacturers who benefit from the entire surplus resulting from lower costs, if the feed-in tariffs are not adjusted in step with technical change. In the case of competitive bidding, producers must pass

on cost savings to taxpayers or consumers. This distribution of the surplus has two consequences:

The technological learning effects have been much greater for manufacturers in countries that have opted for feed-in tariffs because of the strong growth in generating capacities. Remember that the three leading countries in Europe, stimulated by feed-in tariffs, installed 20 times more generating capacity in 2000 than the countries operating competitive bidding schemes.

The reduced margins inherent in the bidding system have limited the R&D investment capability of manufacturers and their suppliers. Consequently, in interdependent economies operating different support mechanisms, the reduction in costs observed for wind power generating systems with bidding systems is helped by the technical progress made by manufacturers in countries where support policies are more favourable. In these countries, since firms are allowed to benefit from the differential profit, feed-in tariff schemes have enabled manufacturers to invest more heavily in R&D and to consolidate their industrial base<sup>52</sup>.

*Green certificates: a new quantity-based approach compatible with the liberalisation of the electricity market*

Despite their apparent effectiveness in stimulating the development of renewable energies, feed-in tariffs could be replaced over the next few years by a system of green certificates. The reason for such a possible change is two-fold:

- The rapid growth in production and the corresponding increase in RES-E subsidies,
- The liberalisation of the electricity sector in Europe. The cost of supporting renewables, when unequally shared, distorts the competition between suppliers, a situation which is incompatible with the opening up of the European market desired by the Commission.

Feed-in tariffs could develop in such a way that they do not distort competition and so that all consumers contribute to supporting renewable energies. In 2000, Germany set up a system of sharing the cost of supporting renewable energies among the electric utilities. Nevertheless, green certificates, designed to allow compatibility of incentive frameworks with the opening up to competition, are more adapted to the new types of electricity market (Voogt et al, 2000; Wohlgemuth, 1999).

### The contribution of green certificates

Through the system of green certificates, renewable energy generation is becoming, to a certain extent, an integral part of the electricity market, instead of being separate as in the case of other incentive schemes. Green certificates are attributed to RES-E generators who exploit the power they generate in two different ways: by selling the electricity at the wholesale market

<sup>51</sup> New legislation in Germany – EEG law, Spring 2000 – and in France – wind energy tariff decrees, Autumn 2000 – provides a first response to this problem (cf. infra).

<sup>52</sup> In 1998, Germany, Denmark and Spain were home to eight of the ten biggest wind turbine manufacturers in the world. On the other hand, in the United Kingdom, the government has not reached its goal of developing a competitive renewable energy industry.

price, and by selling certificates to operators who have a particular quota to meet. Support mechanisms for renewable energy development are then no longer unrelated to electricity price changes, as was the case with competitive bidding schemes and feed-in tariffs. The total price per renewable kWh, which is equal to the wholesale market price plus the price of the green certificate per kWh, should in theory correspond to the full cost of the marginal unit to be installed during the growth period of green electricity. Conversely the green certificate price at one time would be established as the difference between this marginal cost during the development phase and the wholesale market price.

Under the system of green certificates, RES-E generation objectives can be imposed on electricity distributors/retailers with an aim of achieving overall allocation efficiency when they have access to different resources. Green certificate trading in fact makes it possible to use the least costly energy sources, for a single technology (coastal regions before inland areas) and for several competitive technologies (wind power before photovoltaic). But this advantage may become a disadvantage, from a dynamic point of view, since it tends to prevent investment in promising – but insufficiently developed – technologies. This type of system is of particular interest in an international context where trading possibilities are greater than at a purely national level, in particular where the electricity market is small or where one operator supplies virtually the entire national territory, as in France.

Such a system should thus be of particular interest in Europe with the introduction of the European Directive on green electricity defining national objectives for RES-E generation for 2010. The Directive assigns differentiated objectives to Member States in order to take into account existing potential and the efforts already made. However, since the marginal production cost curves for each country are not known, this allocation may not be the most efficient way of sharing the burden<sup>53</sup>. Through the system of tradable certificates, priority could be given to using the least-cost resources, so that the overall target will be reached in the most economic way.

The theoretical interest of certificates must not however mask the problems associated with the organisation of certificate exchanges. For a green certificate market to work, new functions must be guaranteed – certification of RES-E producers, trade register, accounting and auditing, with penalties imposed in the event of failure to respect obligations – all of which lead to high administration costs. So as not to place too much initial pressure on the price of certificates, the quotas imposed must be moderate at first then increase gradually in step with development possibilities.

The main risk in this type of system is the volatility of the certificate price and its negative effects on investors, which happens if the market is limited and lacking liquidity due to a small number of participants (Morthorst, 2000). On the supply side, a supplier wishing to enter the market must be able to anticipate future prices and make his project “bankable” in order to secure a loan to enable him to invest in new production capacity. The creation of a futures market with long term contracts would be a way of limiting certificate price volatility caused by meteorological factors and estimating the future profitability of projects. On the demand side, borrowing or banking mechanisms are other possible ways of limiting price fluctuations that might result from overly strict limits on the validity of certificates.

### Expected efficiency of certificate system

The system of tradable green certificates is similar to the quantity-based mechanisms examined earlier but differs from a bidding system in that each operator is assigned quantitative objectives. The concrete performance of green certificate trading cannot be assessed on the basis of experience, since such mechanisms have so far been introduced only in some countries. Nevertheless, a number of potential advantages can be mentioned.

- *Stimulation of new RES-E generation capacity.* Environmental policy objectives can be easily defined in quantitative terms, allowing a steady progression from a known initial situation by introducing increasingly more ambitious quotas. Anyway, the possibility of anticipating future prices, along with sufficiently profitable price levels, are essential conditions if such projects are to remain attractive to investors. A futures market could enable this difficulty to be overcome if the market is sufficiently liquid. With the growth dictated by an evolving quota system, market prices will in principle be sufficiently profitable because of the increasing demand for certificates.
- *Incentive to lower costs.* The creation of a green certificates market provides a double incentive to lower costs. First, the electricity produced by RES installations is sold on the grid at the market price, which tends to be falling due to deregulation and increased competition. Second, producers of renewable electricity are under the constant pressure of competition because of the green certificate market. This pressure creates incentives for potential investors not only to control the cost of equipment but also to control operating costs once the equipment is installed.

### Conclusion

In ideal theoretical situations, price-based and quantity-based approaches are seen as comparable methods for achieving RES-E targets. But this symmetry is no longer applicable when uncertainty is taken into account. As a consequence, different criteria should be considered when evaluating the efficiency of such

<sup>53</sup> For example, Germany, which has been given the objective of increasing RES-E consumption from 2.4 % in 1997 to 10.3% in 2010 and where wind energy potential is limited and already widely exploited, may have to make a greater effort than Ireland, whose target is to increase green electricity consumption from 1.1% in 1997 to 11.7% in 2010 and which has abundant wind energy resources.



incentives, and in particular the question of stimulating technical change:

- *Policy cost control.* It is clear that the quantity-based approach is the more effective in controlling the cost of government incentive policies: by inviting tenders for successive quotas it is possible to maintain direct control over installed capacities and indirect control over the marginal production cost and thus over the cost for the community. Similar control is also maintained through the quotas imposed on electricity suppliers under green certificate schemes. Conversely, in feed-in tariff systems, RES-E production cannot be anticipated with any precision because of the uncertainty regarding cost curves. It would of course be theoretically possible to adjust prices according to the response of producers, but in a neutral environment. In practice, this type of control would be difficult to implement for political and institutional reasons, making it difficult to adjust quantities and thereby control the cost for the community.
  - *Installed capacities.* In terms of installed capacity, price-based approaches have given far better results than quantity-based approaches. In theory, there should be no such difference, since bidding prices established at the same level as feed-in tariffs should logically give rise to comparable installed capacities. The difference can be explained by the attraction of fixed prices, which project developers see as ensuring a safe investment with better predictability and a stable incentives framework, as well as by the lower transaction costs for each project.
  - *Stimulation of technical change.* The incentive to reduce costs is much stronger in the competitive bidding system, since competing producers must reflect lower costs in prices in order to win subsidies. In a system of feed-in tariffs, there is less incentive to lower costs, since drops in production costs have not systematically been reflected in the feed-in tariffs (Germany until 2000). However, it is possible, as demonstrated by the new incentive policy in France, to provide for a gradual reduction in feed-in tariffs to take into account the progress made in renewable technologies.
- Other dynamic factors also play a role. First, greater new installed capacity allows cost reductions through technological learning on the part of national manufacturers. Second, feed-in tariffs enable manufacturers to invest more heavily in R&D and to consolidate their industrial base. This is evidenced by the fact that Denmark, Germany and Spain are the world leaders in wind turbine production.
- *Other public policy objectives.* Finally, while competitive bidding systems in theory allow the introduction of many selection criteria to take into account objectives concerning land development or minimisation of the pressure exerted on the best sites, it can be seen that such objectives have been better achieved in countries operating feed-in tariff systems. Moreover, these objectives are not in-

compatible with feed-in tariff mechanisms, as shown by the German and French systems in which adjustable tariffs have been introduced to encourage the development of wind power projects on supposedly less attractive sites.

The greater efficiency of feed-in tariff mechanisms in helping countries to achieve renewable energy development targets is confirmed by the gradual disappearance of competitive bidding systems in the wake of low project implementation rates. But the price/quantity issue is by no means settled. The potential advantages of a quota-based green certificate trading system are prompting an increasing number of countries to use such schemes to meet ambitious goals for new energy generating capacity in a cost-effective way. Compared with other instruments, green certificate trading provides the best opportunity for distributing an overall objective in the most efficient way among several technologies and for organising renewable energy development on the scale of several countries. But given the limited experience with green certificate markets, and as long as uncertainties persist concerning market operation and the creation of a framework that is considered stable by investors, its real efficiency has still to be proven.

## References

- Berry, T., Jaccard, M., 2001, The renewable portfolio standard: design considerations and an implementation survey, *Energy Policy*, 29 (4), pp. 263-277.
- Brunt, A., Spooner, D., 1998, The development of wind power in Denmark and the UK, *Energy and Environment*, 9 (3).
- Chabot, B., 2000, Allemagne: des mesures sans précédent, *Systèmes Solaires*, (139), pp. 7-15.
- Christiansen, A., C., 2001, *Technological change and the role of public policy: an analytical framework for dynamic efficiency assessments* /- Report of The Fridtjof Nansen Institute, 2001, 74 p
- European Commission, 1999, *Electricity from renewable energy sources and the internal electricity market*, Working Paper of the European Commission, SEC 99470, Bruxelles.
- European Commission, 2001, Directive 2001/77/CE of the European Parliament and Council dated 27 September 2001.
- Elgreen, 2001, *Action Plan for a Green European Electricity Market*, Energy Economics Group, Institute of Power Systems and Energy Economics, Vienna University of Technology, Vienna.
- Intergovernmental panel on Climate Change (IPCC), 2000, *IPCC special report, scénarios d'émissions, Résumé à l'attention des décideurs*.
- Gutermuth, P-G, 2000, Regulatory and institutional measures by the state to enhance the deployment of renewable energies: German experiences, *Solar Energy*, 69 (3), pp. 205-213.
- Kühn, I. et alii, 1999, New competition-based support schemes for electricity generation from renewable energy sources, Conference on *energy market liberalisation in Central and Eastern Europe*, Prague, September 1999.
- Mitchell, C., 1995, The renewable NFFO, A review, *Energy Policy*, 23 (12), pp. 1077-1091.
- Mitchell, C., 2000, The England and Wales Non-Fossil Fuel Obligation: history and lessons, *Annual Review of Energy and Environment*, (25), pp. 285-312.

- Morthorst, P.E., 1999, Danish renewable energy and a green certificate market, Conference on *The Design of energy markets and environment*, Copenhagen (DK), 20-21 May 1999.
- Morthorst, P.E., 2000, The development of a green certificate market, *Energy Policy*, 28 (15), pp. 1085-1094.
- Voogt, M., Boots, M.G., Schaeffer, G.J and Martens, J.W., 2000, Renewable electricity in a liberalised market: the concept of green certificates, *Energy and Environment*, 11 (1).
- Wagner, A., 2000, Set for the 21<sup>st</sup> Century: Germany's new renewable energy law, *Renewable Energy World*, 3 (2).
- Wohlgemuth, N., 1999, Renewable energy promotion in competitive electricity markets, Solar Energy Society, London

## Efficiency criteria for promoting electricity generation from renewables

Claus Huber, Reinhard Haas, Thomas Faber, Gustav Resch, *Energy Economics Group, Vienna University of Technology*.<sup>54</sup>

### Introduction

Increasing the share of renewable energy sources for electricity generation (RES-E) has a high priority in the energy strategies of the European Commission. However, to facilitate a breakthrough for RES-E, several economic, institutional, political, legislative, social and environmental barriers have to be overcome. Yet, currently, despite the wide range of strategies implemented in different EU countries, it is debatable which is most effective for increasing the dissemination of RES-E (Haas et al 2001). To assist such analysis, the project 'Organising a joint green electricity market – **EIGreen**' funded by the EC has been completed (Huber et al 2001b).

The core objective of this project is to find out how to bring about the enhancement in market penetration of RES-E in the cheapest and most efficient way, from the society's point-of-view by minimising public costs. The objectives of **EIGreen** in detail are:

- To summarise the current state-of-the-art and to evaluate the performance of various policy instruments applied previously and currently, especially for EU Member States;
- To conduct a formal analysis of how different types of strategies work;
- To develop the computer model **EIGreen** with both bottom-up and top-down features;
- The top-down approach models harmonised strategies for RES-E within the European Union;
- The bottom-up approach allows different strategies by country and technology;
- To propose action plans for practical implementation of the recommendations.

### Method of approach

The major objective of this project was to evaluate the efficiency of various types of promotion strategies for renewables for electricity generation and to derive recommendations for EU policy strategies. To do so it must be born in mind that such instruments have to be (i) effective for increasing the penetration of RES-E and (ii) efficient at respect to minimise the arising public costs. The criteria used for the evaluation of various instruments are based on the following conditions

#### 1. Minimise generation costs:

This aim is fulfilled if incentives for investors are provided to choose technologies so that generation costs are minimised (Resch et. al. 2001).

<sup>54</sup> Gusshausstrasse 27-29/373-2, A-1040 Vienna, E-mail: Claus.Huber@tuwien.ac.at

## 2. Lower producer profits:

In a second step various options are evaluated with the target to minimise costs for society. This means that feed-in tariffs, subsidies or trading systems should be designed in a way that public transfer payments are also minimised. Yet, this implies lowering producer surplus (PS)<sup>55</sup>.

For a better illustration of the used cost definitions the various cost elements are depicted in Fig. 8.

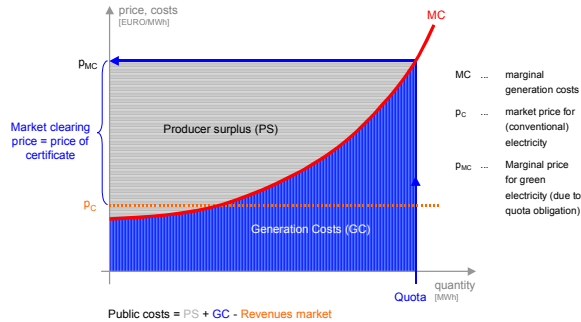


Fig. 8. Basic definitions of the cost elements (illustrated for a TGC-system)

For the evaluation of different dissemination strategies the computer-model **ElGreen** has been developed (Faber et. al. 2001). Its major features are described in Fig. 9. It allows investigation of the impacts of different kinds of instruments. In the following section the most important elements of the computer model are presented.

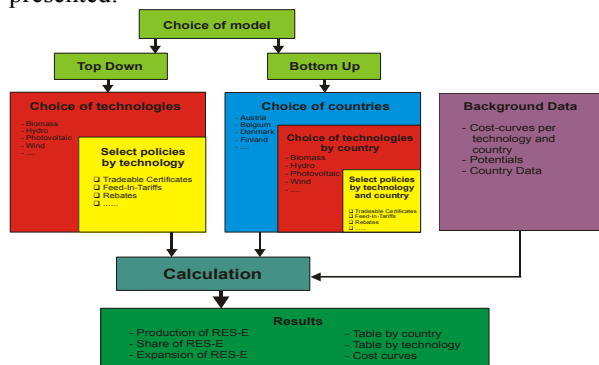


Fig. 9. Elements of the computer model **ElGreen**

## Optimal design of Feed-in tariffs

For substantial dissemination of RES-E, feed-in tariffs have been successful in all countries where they have been introduced to guarantee a fair payment. The major advantage of a feed-in tariff is that it is flexible, fast and easy to establish. The major criticism of feed-in tariffs (as with all other price driven instruments without tendering) is that they do not encourage competition between generators.

Under the following assumptions and conditions, feed-in tariffs are also an economically effective dissemination instrument:

- Flat cost curve!

The cost curve of the technology is flat and predictable with high probability. As cost curves are more predictable in a smaller market, feed-in tariffs are more suitable if implemented nationally, or even locally, rather than internationally.

- Ensure a stable planning horizon!

The duration of a feed-in tariff must be guaranteed by highly credible sources<sup>56</sup> (or by a signed contract).

- Feed-in tariffs should decrease over time!

The price of feed-in tariffs should decrease over time, in line with the expected learning curve giving investment cost reductions. This means that feed-in tariffs for new facilities and, hence, new contracts, should be adopted every year according to the technological progress.

- Limit the time where producer can receive a guaranteed tariff!

The time for a producer to receive a guaranteed feed-in tariff should be limited to a predefined period, i.e. similar to the rolling redemption approach in the case of a TGC system. A period of 10 years seems to be optimal, because this corresponds to the typical repayment time expected by potential investors. Furthermore, from the European Union's point-of-view, a shift to a harmonised strategy among all EU Member States is feasible if the guaranteed duration time is restricted in countries utilising feed-in-tariffs. In this case the transition time from the old to the new system is likewise restricted.

- Design a stepped feed-in tariff!

The subsidy of successive phases of feed-in tariffs should be decreased as the actual generation from each phase increases. The decline in the guaranteed price, however, must be less than the total revenue that can be gained if an efficient plant and location are chosen, otherwise investors have no incentive to implement the most efficient technologies and locations. This means that profits must be higher at cost efficient locations compared to less efficient ones<sup>57</sup>. The principle of this scheme is depicted in the lower part of Fig. 10.

Note: lower part of figure – producer surplus according to standardised baseline; upper part – transfer of the incentive-compatible contract to the feed-in tariff scheme.

Given the fundamental objective of minimising total costs to society, next a stepped feed-in tariff scheme should be analysed in more detail. In Fig. 10, the public gain is characterised by the hatched line. Under such conditions this scheme is similar to a tendering

<sup>55</sup> The producer surplus is defined as the profit of the green electricity generator. Example: if a green producer receives a feed-in tariff of 6 € Cent/kWh and his generation costs are 4 € Cent/kWh, the resulting profit would be 2 € Cent for each kWh. The sum of the profits of all green generators defines the producer surplus.

<sup>56</sup> Without any guarantees, potential producers are afraid to invest in RES-E. This is valid especially for technologies which are far away from economic efficiency. E.g. in Carinthia, a province of Austria, a feed-in tariff for PV of 72,7 € Cent/kWh (10 ATS/kWh) will be paid. Nevertheless, due to the non-secured duration of this tariff, to date no additional capacity whatsoever has been installed.

<sup>57</sup> E.g. wind energy: 20% expected profit for locations with 2400 full-load hours and 14% for locations with 1800 expected full-load hours. In the new German feed-in tariff scheme ('Erneuerbare Energien-Gesetz') the incentive compatibility constraint is fulfilled for the case of wind energy.

system, but with the difference that the subsidised price for RES-E is given by the government and not by the market itself. Under the assumption of a 'perfect' market, the feed-in tariffs set by the government will still lead to inefficiency as compared to tendering. Considering, however, strategic bidding and the much higher administration costs of the tendering scheme, a feed-in tariff seems to be the more efficient solution.

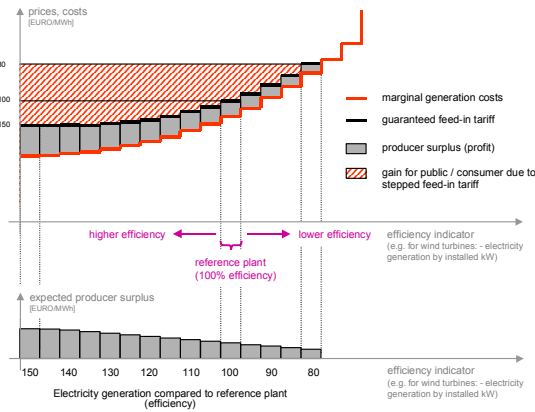


Fig. 10. Optimal incentive-compatible feed-in system

One important condition for such a scheme is the measurable and standardised unit or baseline used for differentiation. If the costs for electricity generation are mainly based on the full-load hours, the latter can be such a suitable baseline. In this case, there is less dependence on specific, not standardised, criteria such as fuel costs or the special conditions of the location. Unfortunately, not every renewable energy technology fulfils this constraint. For wind energy or biogas this criteria is fulfilled, i.e. a stepped feed-in tariff is easy to implement. In the case of biomass, where costs depends on the specific fuel input (bark or wood chips from forest residues) an evaluation of the fuel mix must be made. This causes an increase of the administration costs and hence to a less efficient system. However, in principle, an incentive compatible scheme is implementable<sup>58</sup>. Similar problems exist with applying this scheme to hydro power, where generation costs depend on full-load hours and investment costs, which both depend on the specific characteristics.

If one major political and societal objective is to promote a homogeneous distribution of a RES technology (e.g. wind plants should not only be located near the shore) the 'stepped' feed-in tariff must be adjusted so the producer's profits from generating electricity is independent of the generation costs, see Fig. 11<sup>59</sup>. Furthermore, by granting a 'marginal' higher profit if investor choose an efficient plant, a compromise between cost efficiency (and the disadvantage of location hot spots) and homogeneous distribution (and the disadvantage of economic inefficiency) can be adjusted.

<sup>58</sup> In this case, different feed-in tariffs exist in parallel, depended on the fuel input.

<sup>59</sup> E.g. wind energy: 12% expected profit for locations with 2400 full-load hours and 12% for locations with 1800 expected full-load hours. Hence, plants will be built on cost efficient and less cost efficient locations to the same amount.

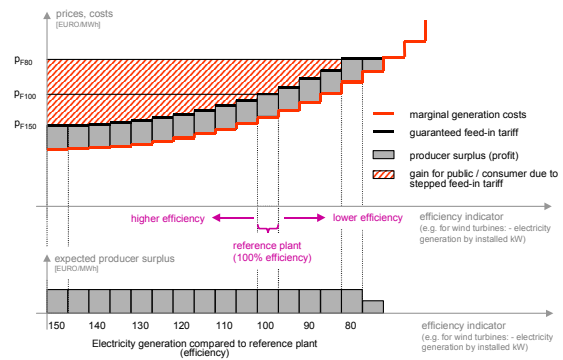


Fig. 11. Feed-in system creating a homogeneous distribution

Note: lower part of figure – producer surplus according to standardised baseline; upper part – transfer to feed-in tariff scheme.

In addition, feed-in tariffs are useful in promoting a more homogeneous distribution among different technologies by setting technology specific guaranteed tariffs. By implementing such a policy, the long-term technology development of various RES, which are currently not cost-efficient, can be supported. The reason is that due to the application of non-mature technologies a dynamic process can be started (i.e. stimulation of the learning-curve) which could lead to a significant decrease in future generation costs. However, this positive effect of feed-in tariffs must be compensated by economic distortions among the RES. By applying a stepped feed-in tariff, producer surplus between the technologies can be adjusted in a way that a homogeneous distribution appears<sup>60</sup>.

### Optimal design of a quota system based on TGCS

In the following, the optimal design of a TGC system will be discussed. In principle it does not matter if this system is based only on mandatory demand or on a combination of mandatory and voluntary demand. The most important framework conditions are:

- Standardise TGCs!

Within a mandatory system, standardisation of TGCs becomes important. The market for TGCs will be most efficient if there is just one kind of certificate, thereby giving higher market transparency, trading volume and the encouragement for producers to seek most efficient forms of renewable energy. However, for the promotion of less mature technologies, or technologies with higher generation costs (e.g. PV), government should use other policy instruments than just including all renewables as a single technology.

- Ensure a stable planning horizon!

One of the most important issues relates to the need for a long-term planning horizon with planning certainty. It has to be guaranteed by highly credible authorities that the TGC trading system will exist for a specified and sufficient planning horizon, otherwise potential producers will be wary of investing in RES-

<sup>60</sup> The value of the subsidised feed-in tariff depends on the slope of the marginal cost curve of different technologies.

E<sup>61</sup>. This connection is illustrated for one technology with ‘relative’ high marginal generation costs in Fig. 12.

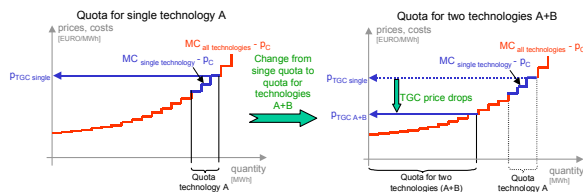


Fig. 12. Effects of a strategy change from a single technology quota to a quota for two technologies

Assume that a single quota for this technology A exists. Due to the high marginal generation costs, a ‘high’ price level for the TGCs,  $p_{TGC\ single}$ , can be expected (see left-hand-side of the Fig. 12)<sup>62</sup>. If, it is not certain that the single quota would survive for several years, then investments will not take place<sup>63</sup>. Consider for example that the single quota for technology A, e.g. small hydro power (SHP), shall be replaced by a quota for two technologies A+B, e.g. SHP and wind, in future years. Under this new framework conditions current investments into new facilities for technology A are uneconomical.

More importantly from the European perspective is that the same situation can also occur on an international level. If in a certain country with a national quota, marginal generation costs are relatively high compared to the international level, and if it is not secured that this quota remains available for national production over a specified period, then potential national producers will have less incentive to invest in RES-E. In other words, without the security that the current system survives over a specified time-period, the fulfilment of the quota is hardly attainable in countries with high generation costs<sup>64</sup>. Moreover, if a system starts in countries with low generation costs and if the system is extended over time to countries with higher costs, high windfall profits come to the generators in the ‘low’ cost countries. The recommendation regarding such changes is that the old system should remain available for a certain transition period and that the new system should start alongside for newly installed facilities. Both should have assured framework conditions.

- Differ between existing and new capacity!

From the public’s point-of-view, TGCs should only be issued over a pre-defined period of time, i.e. the age of the plant has to be considered. More precisely, no

existing or no at least fully depreciated plant should be included in a quota system, otherwise substantial windfall profits occur. This means that it is counterproductive to include old depreciated facilities into a trading system, see Fig. 13.

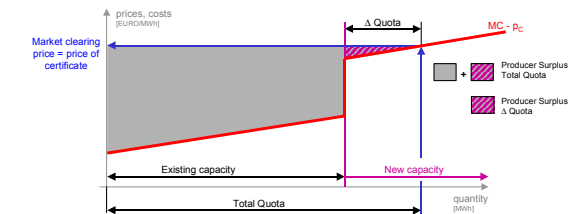


Fig. 13. Comparison of producer surplus with and if existing capacity is included or not

- Use rolling redemption!

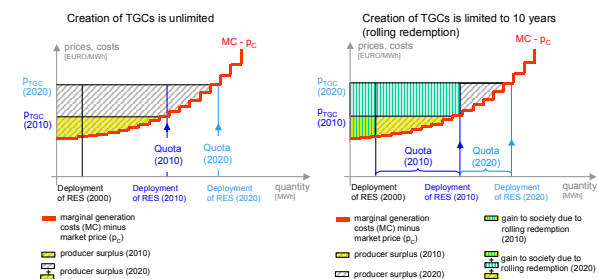


Fig. 14. Comparison of gains due to unlimited and restricted time for the creation of TGCs

Note: Assumption: 10 years internal depreciation time for producers.

The distinction between new and old plants should not be seen only from a static point-of-view. The rolling redemption provides a dynamic solution. In practice such a system can be implemented for plant, not older than, say, 10 years. Hence, the issuing body awards TGCs only to these facilities. The advantage of a rolling redemption for both customers and public is illustrated in Fig. 14. Moreover, to set incentives for maintenance, upgrade, expansion and revitalisation of existing plant, TGCs should be issued also for the incremental generation of electricity of such facilities.

- Avoid volatility of TGC price!

The volatility of the price for TGCs may cause a serious barrier for a potential investor, see Cleijne and Ruijgrok (2001), Morthorst (2000). This problem can be prevented or diminished by having a fixed price floor (guaranteed by government) and ceiling (e.g. a penalty – see later) or by allowing banking and borrowing. Additionally, if banking and borrowing are allowed, the introduction of a future market may help to decrease fluctuations with respect to prices for TGCs.

- Restrict banking and borrowing!

The validity and, hence, the possibility of banking should be restricted to a period of at most five years, a period long enough to offset fluctuations in generation due to stochastic climatic conditions (e.g. variation in wind or water supply), and small enough for strategic collections of TGCs. To keep the system as simple as possible, banking without interest payments is preferred. In addition, borrowing for two to three years

<sup>61</sup> The same situation applies, of course, also for a feed-in tariff.

<sup>62</sup> Note that it is irrelevant for this effect if this quota is imposed at a national or international level.

<sup>63</sup> TGC price for technology A will drop from  $p_{TGC\ single}$  to  $p_{TGC\ sum}$ , see right-hand-side of Fig. 12.

<sup>64</sup> However, by setting an extremely high penalty in the case of non-fulfilment of the obligation, generators can be compelled to invest in RES-E. Still this method is not considered to be optimal because if the system changes from being national to international, inefficient plant would have been built, which would not be competitive under the new conditions. Hence, this situation leads to high economic inefficiencies.



will result in greater price stabilisation. To avoid borrowed TGCs not being repaid (e.g. due to bankruptcy of the obliged organisation) obligated actors should provide a deposit sum, which is returned when the obligation is fulfilled.

- Set the 'correct' penalty!

For the fulfilment of the obligation it is important that the penalty for not purchasing a certificate is higher than the investment needed to meet the quota. This means that the lowest penalty must exceed the expected marginal generation costs (minus market price for conventional electricity) within the system. As the penalty serves as price ceiling for TGCs, it should be higher than the expected market price for TGCs. This fact is depicted in Fig. 15 in more detail. The case on the left-hand-side is characterised by no distortions due to 'wrong' penalty setting. This means that all penalties for the countries A, B, and C are higher than the additional marginal costs and hence the market price for TGCs. Under this assumptions the quota for all countries A, B, and C will be reached. The impact of a 'wrong' penalty setting is depicted on the right-hand-side of Fig. 15. As the penalty in country C is lower than the additional marginal costs for providing TGCs, total demand will be less than obligated. In this case only country A and B have an incentive to reach their quota. For actors in country C it is rational to pay the penalty C rather than fulfil the quota at the given market price  $p_{TGC}$ . In this case the quota  $Q_{A+B+C}$  will not be reached.

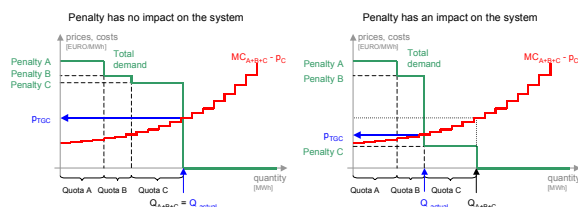


Fig. 15. Influence of the penalty on the electricity generation: high penalty (left) and low penalty (right)

- Strive for an international trading system!

In principle it is also conceivable that a European-wide trading system will not bring benefits to society as compared to detached national trading systems. This would occur if, in most countries, marginal generation costs are low and available potential is already mostly achieved. Fig. 16 illustrates this connection for two countries A and B.

Total costs (generation costs plus producer surplus) in the case of international trade are depicted on the right of Fig. 16. Because marginal generation costs to fulfil the national quota are lower in country A than in country B, the market clearing price in country A, i.e.  $p_{TGC A}$ , is lower than the TGC price for international trade, i.e.  $p_{TGC A+B}$ , and for national trade in country B, i.e.  $p_{TGC B}$ , respectively. Lower price leads to lower electricity generation and lower social costs, see left section of Fig. 16. Similarly, due to a higher national TGC price in country B, electricity generation is higher than with international trade, and, therefore, total costs for the society increase also, as indicated on Fig. 16.

However, if the social gain for national trade in country A exceeds the social losses in country B, national trade is preferable to international trade. Such a situation is much more probable if both old and new plant is included in a quota system. However, in practice, the results from the simulation with the computer-model **ElGreen** show that in all investigated cases<sup>65</sup> international trade leads to lower costs to the society. Hence, it can be concluded that in order to reduce costs to EU society as a whole, international trade should be preferred to national trade.

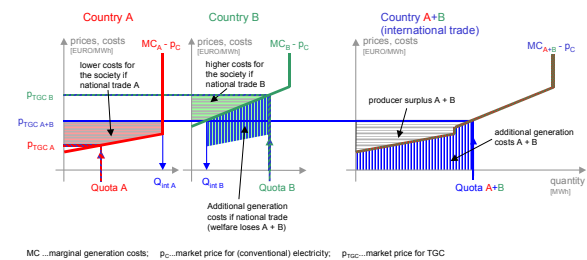


Fig. 16. Comparison of benefits from national and international trading

- Allow international trade between countries with quota obligations!

International trade between countries with quota obligations is possible if the governments allow energy purchasers to use foreign TGCs as proof that they have fulfilled their obligations. In a long-term international system, one single market price for TGCs would be formed. If actors in both countries have to fulfil their quotas, the total production of RES will not be influenced by the international trading activity, only the distribution of total generation in the two countries would change. Countries with high marginal generation costs (due to a low potential for RES or due to a high obligation) will be net importers, and countries with low marginal generation costs will be net exporters. From the environmental point-of-view, less adverse impacts are expected from allowing international trade. However, negative effects from international trading could occur at geographical hot spots, because of extensive use of a certain technology at an optimal location (e.g. visual intrusion of extensive wind power development in areas of high wind speed, to be set against the benefits of income for those regions).

- Avoid import of TGC from countries with no quota obligation!

International trade between, on the one hand, countries with a quota obligation and, on the other hand, countries without a regulatory quota creates an implicit asymmetry. This is especially problematic if installed capacity of RES in the country with a voluntary system has been promoted by an investment subsidy and low voluntary demand. This means that the price that can be received from RES-E is similar to the price of conventional electricity. By receiving higher prices, generators will export their electricity to the country with

<sup>65</sup> For details see 'Final Report of the project ElGreen' (Huber et. al., 2001b).

the quota obligation. Thus, significant supply of TGCs occurs in the country with the mandatory obligation, so contributing to a decrease in the price of TGCs. This flow will make it easier to achieve the obligation. However, the intention of a mandatory quota system may be effected, e.g. the stimulation of national production of electricity from RES. It could not be assured that the export of TGCs leads to an additional deployment of RES in the country without the obligation. The reason is that the exported share of green electricity could be substituted by generation from conventional power plant. From an international perspective, countries with a mandatory quota system might not want to accept TGCs from countries with only a voluntary demand approach. TGCs from a country without an obligation should only be accepted if it is proved that the plant is implemented due to the stimulation of the trading system. This means that TGCs must be created from newly installed RES<sup>66</sup>.

- Avoid additional support schemes!

With respect to a European-wide transboundary trading system, it is especially important to avoid discrimination between countries. This means that additional support mechanisms in all countries must be known<sup>67</sup>, with subsidy schemes transparent and the related information accessible. Otherwise the option of TGC trading will be an additional subsidy instead of a cost efficient way to promote RES. If subsidies differ among the countries, then distortions will occur, because marginal generation costs also differ among the countries. The consequence is that producers in countries with higher subsidies will increase the generation, and producers with lower support will decrease generation compared to the optimal case. However, the governments, and indirectly the taxpayers and electricity consumers, of the countries with higher subsidies support not only the price of the certificate in their own country but also in all other countries. This means that subsidies granted in one country will lead to a price fall in other countries, even if support schemes exist in those countries<sup>68</sup>. In addition, to increase the efficiency of the trading system, it is important that no hidden market barriers exist, e.g. the condition that only TGCs can be imported if physical electricity is imported, too.

## Conclusions

The most important conclusions of this analysis are:

- Regardless which instrument is chosen the careful design of a strategy is more important than the question of whether feed-in tariffs or a national or international quota/TGC system is implemented. A poorly designed system is worse than no promotional system at all ;
- It must be guaranteed by highly credible sources that the promotional strategy, regardless of which instrument is implemented, survives for a specified planning horizon;
- The support mechanism of any instrument should be *restricted to a certain time frame* e.g. 10 years.
- All selective *barriers for new RES-E generators* should be rigorously removed, e.g. fees for connection to the grid, extraordinary transmission fees.
- A TGC system is only preferable to feed-in tariffs if it is introduced as a transboundary system on a European-wide scale; Currently, however, it is very unlikely that such a harmonised strategy will be implemented soon. Therefore, promotional schemes based on stepped feed-in tariffs are the best strategy until international trading scheme can be implemented;
- Feed-in tariffs are preferable to national trading schemes for three reasons: (a) they are easy to implement and can be revised for new capacities in a very short time (if the duration of each specific guaranteed tariff is limited to, say, 10 years); (b) administration costs are usually lower than for implementing a national trading scheme. This fact is especially important for small countries where a competitive national trading scheme is difficult to implement; (c) a clear distinction between the non-harmonised strategy for existing capacities (the stepped feed-in tariff) and the harmonised strategy (international trade) for new capacities is possible. This is very important to avoid uncertainties and backlashes in the period in which the framework conditions for a possible new harmonised system are negotiated;
- Otherwise, if every country tries to implement its own national system (with or without international trade) a hopelessly confusing mix-up between the different system occurs and the transaction costs to harmonise the systems afterwards will be very high.
- Moreover, there is *no need or reason to change the strategies for existing RES-E capacities*, either EU-wide or on a national level;
- This leads to the following **major conclusion for a joint harmonised EU-strategy**, when all EU-countries agree on a joint harmonised Quota / TGC-strategy. For this, *a clear starting point has to be defined*, e.g. January 1st 2007 as in Fig. 17. From then, *all new capacity, but no existing capacity, would qualify for the Quota / TGC system*.

<sup>66</sup> The situation described above is to some extent similar to the status of the Clean Development Mechanism (CDM) in the case of international climate change policy. Applying CDM-projects is only feasible if it is secured that the emission reduction in the country without a mandatory emission restriction (developing country) is due to the implemented project.

<sup>67</sup> In a purely national or local market, the question whether or not the producers are subsidised will not be important, because all producers will have the same framework conditions. However, distortions between different technologies or technology bands, due to different promotion schemes lead to efficiency losses.

<sup>68</sup> In theory, there are at least two ways to prevent such negative distortions – see e.g. Schaeffer et. al. (1999):

- abolishment of all other support schemes;
- compensation payment for the support at the border.



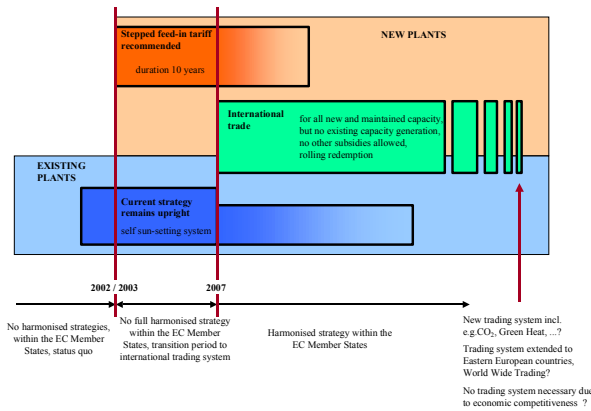


Fig. 17. Transition from existing non-harmonised strategies in various EU-countries to a fully harmonised EU-wide Quota/TGC-system compatible with emission trading

## References

- Cleijne H., W. Ruijgrok (2001): "Bidding strategies on a green electricity market", Report for the European Commission, Project ElGreen.
- Faber T., C. Huber, R. Haas (2001): "Design of the computer model ElGreen" – Internal report of the project "Organising a Joint European Green Electricity Market (ElGreen)", Energy Economics Group (EEG), Vienna University of Technology, Austria.
- Green J., J. Plastow (2001): "Options for labelling Green Electricity in Europe" – Report of the project ElGreen co-financed under the 5th framework programme of the European Commission, IT Power, United Kingdom.
- Haas R., T. Faber, J. Green, M. Gual, C. Huber, G. Resch, J. Twidell (2001): "Promotion Strategies for Electricity from Renewable Energy Sources – Activities in EU Countries", Review Report – Green Electricity Cluster, DGTREN.
- Huber C., H. Cleijne, T. Faber, J. Green, R. Haas, G. Resch (2001a): "Formal framework of the model ElGreen" – Internal report of the project "Organising a Joint European Green Electricity Market (ElGreen)", Energy Economics Group (EEG), Vienna University of Technology, Austria.
- Huber C., T. Erge, T. Faber, J. Green, R. Haas, G. Resch, W. Ruijgrok, J. Twidell (2001b): "Final Report" – Public report of the project "Organising a Joint European Green Electricity Market (ElGreen)", Energy Economics Group (EEG), Vienna University of Technology, Austria.
- Morthorst P.E. (2000): "The development of a green certificate market", System Analysis Department, Risoe National Laboratory, Energy Policy 28(2000).
- Resch G., M. Berger, L. Kranzl (2001): "Database for the Model ElGreen" – Internal report of the project "Organising a Joint European Green Electricity Market (ElGreen)", Energy Economics Group (EEG), Vienna University of Technology, Austria.

## The European Dimension of National Renewable Electricity Policy - The Dutch Experience

Emiel van Sambeek, Energy research Centre of the Netherlands<sup>69</sup>

### Introduction

Last year's adoption of the Renewables Directive<sup>70</sup> has provided an important stimulus for Member State governments to increase their renewable energy policy efforts. The Directive stipulates indicative targets for the consumption of renewable electricity in each of the Member States. This paper uses the recent experiences in the Dutch green certificate market to illustrate the possible interactions between renewable energy policy instruments in the different Member States. Based on the implications of these policy interactions for national RES-E policy making the case for co-ordination and harmonisation of renewable energy policy in the EU is developed.

### The Renewable Electricity Policy in the Netherlands

Under the EU renewables directive the Netherlands was allocated a renewable electricity target of 9% of total electricity consumption in 2010 (European Commission, 2001). This European target is slightly higher than the target that was established on the national level in the context of the implementation of the Kyoto Protocol (Ministry of VROM, 1999). In 1995 the government established the long-term target for the penetration of renewable energy of 10% of final energy consumption in 2020 (Ministry of Economic Affairs, 1997). This is equivalent to approximately 17% of total electricity consumption by that time. In view of the greenhouse gas emissions reduction targets for the first commitment period under the Kyoto Protocol the government formulated an intermediate target of 5% of total energy consumption in 2010. This is estimated to be the equivalent of 8.5% of electricity consumption. To meet these targets the Renewable Energy Action Plan (Ministry of Economic Affairs, 1997) announced an intensification of renewable energy policies and defined a number of targeted actions and instruments to accelerate the penetration of renewable energy in the Netherlands.

Before the start of the liberalisation of the electricity market between 1998 and 2000 renewable energy support came from a mix of instruments ranging from feed-in tariffs based on avoided cost, direct subsidies, fiscal investment incentives and a system benefits charge (MAP levy). As a consequence of the greening of the tax system in the mid-nineties the ecotax or regulatory energy tax (REB) on final energy consump-

<sup>69</sup> Policy Studies, Badhuisweg 3, 1031 CM Amsterdam, The Netherlands. E-mail: vansambeek@ecn.nl.

<sup>70</sup> Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market, OJ L283/33, 27.10.2001.

tion was introduced in 1996. Renewable electricity consumption was exempt from the ecotax. Moreover, producers of renewable electricity receive a production incentive from the ecotax funds collected from non-renewable electricity consumers. Since 1996 this fiscal stimulation has become the dominant policy instrument to promote renewable electricity. Feed-in tariffs are gradually phased out as the electricity market is opened to competition. The system benefits charges (MAP) have been abolished at the end of 2000. Other policy mechanisms such as fiscal investment incentives (depreciation allowances) still remain. In July 2001 the market for renewable electricity was opened to all customers. A tradable green certificate system was set up for the verification, registration and tracking of renewable electricity and to facilitate the trade and retail supply of renewable electricity. The market for non-renewable retail customers will be opened in October 2003 (Platform Energy Liberalisation).

### The Dutch Green Certificate System

Green certificates embody the environmental benefits associated with renewable electricity generation and provide a unique proof that a certain amount of electricity was generated in a renewable way. Green certificates can be traded separately from the physical electricity. A green certificate system comprises institutions, regulations and mechanisms for the issuing, registration, tracking and redeeming of green certificates. In several EU Member States green certificate systems are established to offer enhanced temporal and spatial flexibility in meeting an obligation on producers, suppliers or consumers to fulfil a certain percentage of their electricity generation, supply or consumption from renewable sources. Contrary to other countries the green certificate system in the Netherlands serves to facilitate a voluntary market in renewable electricity. As explained above voluntary demand is stimulated through an exemption of renewable electricity from the ecotax on final energy consumption. The ecotax exemption can be claimed by surrendering a green certificate to the tax authority.

In addition to the ecotax exemption on renewable electricity consumption suppliers can grant a production subsidy to renewable electricity generators from the ecotax revenues on conventional electricity consumption. The administration of this production subsidy is based on power purchase agreements between the producer and the supplier and is not linked to the green certificate system.

Fig. 1 explains the relationship between the Dutch green certificate system and the ecotax incentives for renewable electricity. The figure abstracts from physical electricity flows and transactions, and only considers the transactions related to the green part of renewable electricity production, trade and consumption. Table 1 outlines the development of the level of the ecotax and the production subsidy since the implementation of the ecotax in 1996. The table shows that the level of the ecotax and production subsidy has increased consistently over the years.

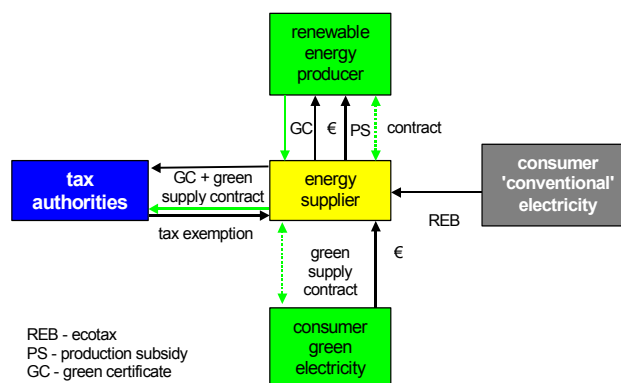


Fig. 1. Schematic overview of the relation between the Dutch GC system and the ecotax.

Electricity suppliers collect the ecotax (REB) from grey electricity customers. Green electricity customers pay a premium (€) for the green electricity but do not pay the ecotax (REB). The suppliers buy enough green certificates (GC) from renewable generators to match their supply of renewable electricity to green customers. Furthermore, based on the power purchase contract between the supplier and the renewable generator, the supplier may grant a production subsidy (PS) to the renewable generator from the ecotax revenues. The supplier transfers the total amount of ecotax collected from its customers minus the sum of the production subsidies to renewable generators (REB-PS) to the tax authorities. Moreover, in order to claim the ecotax exemption on renewable electricity consumption the supplier surrenders its green supply contracts along with a matching supply of green certificates (GC) to the tax authorities.

Table 1. Development of the level of the ecotax exemption and production subsidy for renewable electricity in the Netherlands (all numbers in €/kWh).

User Category [kWh]	1996	1997	1998	1999	2000	2001	2002
Ecotax							
0-800	0	0	0	0	0	0.0583	0.0601
800-10.000	0.0134	0.0134	0.0134	0.0225	0.0372	0.0583	0.0601
10.000-50.000	0.0134	0.0134	0.0134	0.0147	0.0161	0.0194	0.0200
50.000-10 mln.	0	0	0	0.0010	0.0022	0.0059	0.0061
>10 mln.	0	0	0	0	0	0	0
Production subsidy	0.0134	0.0134	0.0134	0.0147	0.0161	0.0194	0.0200

### Implementation of the Netherlands green certificate system

The Dutch GC system started its operation on the 1<sup>st</sup> of July 2001 concurrent with the opening of the green electricity market to retail competition. The Green Certificate Body - a 100% daughter of the national transmission system operator, Tennet - is responsible for the implementation and operation of the system. Initially only domestic renewable electricity production was eligible for the issuing of green certificates. As a consequence only Dutch renewable electricity generation was able to claim the tax benefits associated with the ecotax regulations. However, it was clear from the beginning that such a discriminatory arrangement could not be upheld in view of European regulations. Therefore, with the introduction of the green certificate system the Minister announced that the conditions

under which imports would become eligible would be studied and further regulations on this matter would follow (Ministry of Economic Affairs, 2001a). As of January 2002 foreign renewable electricity became eligible for Dutch green certificates, subject to the following conditions (Ministry of Economic Affairs, 2001d):

#### *Reciprocity*

Only imports from countries that meet the reciprocity criterion as laid down in article 19 of EU Electricity Directive (European Commission, 1996) and as implemented through articles 44 and 45 of the Dutch Electricity Law of 1998 are eligible. This reciprocity clause means that customers in Netherlands for whom renewable electricity is imported should be a non-captive/eligible customer in the country of origin of the renewable electricity. This effectively means that renewable electricity can only be imported from European countries, which have implemented full retail competition.

#### *No double subsidisation*

Importers of renewable electricity have to sign a declaration that the renewable electricity for which the issuance of green certificates is requested has not been sold or subsidised as renewable electricity elsewhere.

#### *Metering data and plant verification*

Metering data as well as information relating to the type of plant has to be provided to the green certificate body by the competent authorities in the country of origin. The Ministry of Economic Affairs has made a list of all parties that have the authority to verify the type of plant and to meter the electricity delivered to the grid according to the national legislation and regulations in all EU Member States plus Norway and Switzerland (Van Sambeek et al., 2002).

#### *Import capacity*

Importers have to demonstrate that they have acquired sufficient transport capacity on the cross-border interconnectors to physically import an amount of electricity corresponding with the amount for which the issuance of green certificates is requested.

#### *Renewable according to the Dutch definition*

Imported renewable electricity should qualify as renewable electricity according to the definition given in article 53 of the Dutch Electricity Law of 1998. This definition includes wind, solar-pv, hydropower under 15 MW, and biomass. Waste is not eligible for green certificates.

### **Recent developments in the renewable electricity market**

The ecotax exemption has been a very effective means of stimulating the consumption of renewable electricity in the Netherlands. Because of the high level of the ecotax renewable electricity can be offered to retail customers at around the same rate as grey electricity. Thus there is currently no financial barrier to switch to renewable electricity. A further stimulus to the promo-

tion of the renewable electricity market is the fact that as of July 2001 the renewable electricity market is the only retail segment that has been opened to competition. Until the electricity market is fully liberalised the renewable energy market provides the only opportunity to expand a supplier's retail customer base. Furthermore, renewable electricity has a strong marketing appeal, which may be a valuable instrument once full competition enters into force. Finally, because of the favourable ecotax regulations the margins on renewable electricity supply are relatively high. The suppliers therefore have a strong incentive to promote the development of a green electricity market. As a consequence of the negligible price difference between renewable electricity and grey electricity and the marketing efforts of suppliers the number of renewable electricity customers has increased from some 250,000 at the beginning of 2001 to approximately one million in mid 2002. Fig. 2 illustrates the steep increase in renewable electricity customers since mid 2001.

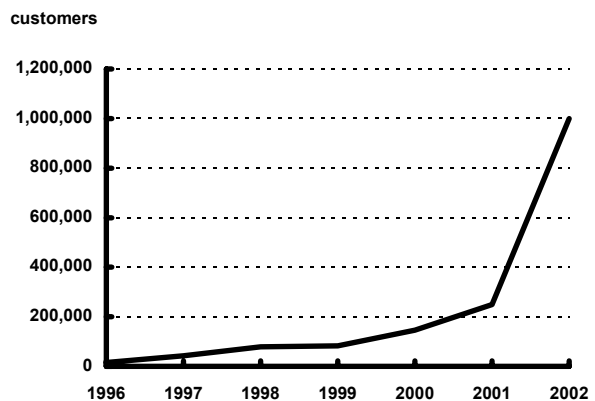


Fig. 2. Increase in the number of renewable electricity customers.

Source: [www.greenprices.com](http://www.greenprices.com).

The current domestic renewable electricity production is sufficient to supply approximately 500,000 households (Platform Energy Liberalisation, 2001). Consequently a large proportion of demand is met through imports of renewable electricity. Fig. 3 gives the volumes of imported and domestic green certificates issued and traded over time. While imports became eligible for green certificates in January 2002 there has been some delay in issuing the green certificates. Therefore the graph shows that the first green certificates for imported renewable electricity were issued in February 2002. Nevertheless, imports of renewable electricity had been going on for some time before 2002. It is estimated that the total volume of renewable electricity imports increased from 1.4 TWh in 2000 (CBS, 2001) to approximately 7.5 TWh in 2001 (Kroon, 2002). It should be noted that all of these imports were at least eligible for the production subsidy. Furthermore, except for the period from July 2001 to January 2002 these imports were also eligible for the ecotax exemption. Imports of renewable electricity thus lead to a vast cost in terms of avoided tax revenues to the Dutch government. Total avoided of

tax revenues in 2001 to support renewable electricity are currently estimated at 205 million Euro: 23 million Euro as a consequence of the ecotax exemption and 182 million Euro from the production subsidy (Parliament, 2002). With total eligible renewable electricity production in the Netherlands in 2001 of around 1.6 TWh and imports of around 7.5 TWh the majority of these costs can be attributed to the import of renewable electricity. From the green certificate statistics (Green Certificate Body, 2002) it can be inferred that cost of avoided tax revenues due to imports from January till October 2002 amounts to almost 250 million Euro.

These imports come from existing plants that have been realised in absence of the Dutch renewable electricity policy. Moreover, these plants would have continued to operate under their national support schemes if the Dutch market wouldn't be more attractive. Thus, the Dutch policy does not trigger additional investments in renewable energy projects abroad.

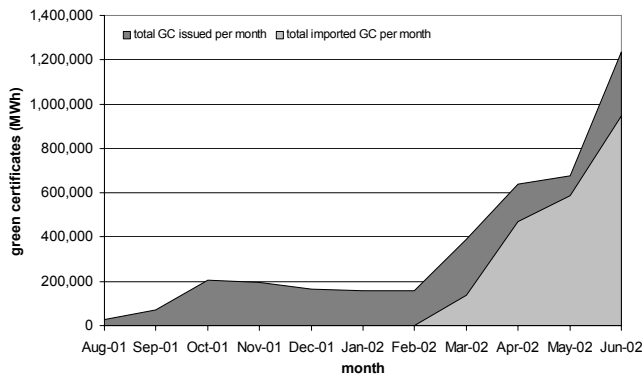


Fig. 3. Green certificate (GC) volumes

Source: Green Certificate Body.

### Sustainability of the Dutch renewable energy support framework

The number of renewable electricity customers is still rising. Moreover, there is increasing interest from the business sectors to purchase renewable electricity ([www.greenprices.com](http://www.greenprices.com)). As domestic supply is fixed in the short run the increase in demand will principally be fulfilled with imports. As renewable generating capacity in the EU is also fixed in the short run the ecotax exemption and production subsidy effectively only establish a reallocation of foreign production from their respective domestic markets to the Dutch renewable electricity market. However, the Dutch support scheme triggers no additional capacity investments in these export countries. If the current favourable investment conditions in the Netherlands are maintained it can be anticipated that new domestic capacity should be added in the coming years to fulfil some of the demand increase. However, exactly here lies the paradox of the Dutch renewables policy framework. Because the support framework is so favourable, including to imports of non-additional renewable electricity, the loss of ecotax revenue to other countries renders the this very support scheme politically and financially unsustainable in the long run. Investors anticipate changes to the support framework to correct for the

loss of tax revenue. Therefore, the scheme is ineffective in providing the long-term revenue security that is needed for investments in new renewable capacity – in the Netherlands or in other countries.

### Analysis of the policy problem for the Netherlands

From the above it becomes clear that the primary policy challenge for the Netherlands is to create investor security to stimulate domestic production and to limit import volumes to reduce tax losses. An analysis of optimal trade flows of renewable electricity to meet the Member State consumption targets under the Renewables Directive with the REBUS model<sup>71</sup> shows that for the Netherlands it is cost-effective to import about 1,3 TWh in 2010 (Voogt et al., 2001). In other words, a cost-effective implementation of the Renewables Directive in the Netherlands requires a certain level of import. Therefore, imports cannot simply be discarded. A sustainable solution to incorporating imports in the renewables policy framework has to be found.

The above considerations with respect to the import of renewable electricity make that the success of the Dutch renewable energy policy is directly linked to the renewable energy policies in other Member States. The value of renewable electricity in any country is primarily determined by the policy framework. Furthermore, trade will always take place in the direction of the highest value. Therefore we need to have a careful look at the policy conditions in other Member States to attune the Dutch policy framework to these conditions.

### RES-E Support Policies in the EU

The dominant renewable electricity policy instruments can be categorised as supply or demand oriented, and quantity or price based. Fig. 4 gives a categorisation of the main policy instruments applied in the EU according to these criteria. Fig. 4 shows that the Netherlands is the only Member State that uses a combination of consumption stimulation and price based policy through the ecotax. Moreover, the ecotax regulations are generic. That is they apply to both domestic production and eligible foreign production. The categorisation in Fig. 4 can be used to identify how the different policy instruments impact on the supply and demand curve for renewable electricity in the Member States. With these supply and demand curves the REBUS model can simulate the trade flows between the different Member States, and evaluate the effect of the ecotax regulations on the value of renewable electricity in the EU and on the volume of import to the Netherlands. As an example Fig. 5 shows the effective supply and demand curves for the Dutch renewable electricity market in 2005 taking into account the poli-

<sup>71</sup> REBUS stands for Renewable Energy BUrden Sharing. The model contains costs and realisable potentials for all renewables in the EU-15. These can be used to evaluate the consequences of the implementation of renewable energy targets and the role of renewable electricity trading. The model assumes a completely open market for green certificates in the EU in 2010. Currently the model is expanded and updated to model the effects of policy interactions on renewable electricity trade and investment.

cies in the reciprocal Member States<sup>72</sup>. Unless new policies are announced a continuation of current policies is assumed. New policies are taken into account to the extent that they are known.

supply	<b>Feed-in tariff / green prices</b> (Germany, Austria, Spain, France, Greece, Portugal, Finland)	<b>Tender</b> (Ireland)
		<b>Obligation for producers</b> (Italy)
demand	<b>Price support of the demand</b> (Netherlands)	<b>Obligation for consumers or suppliers</b> (Denmark, UK, Sweden, Austria (small hydro), Belgium)
	price	quantity

Fig. 4. Overview RES-E support policies in the EU

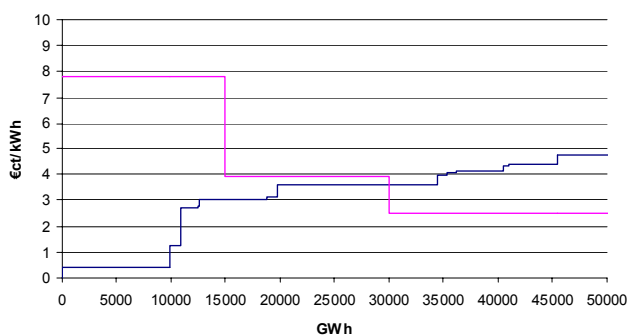


Fig. 5. Supply and demand curve for the Netherlands in 2005

The supply curve for the Dutch market consists of the Dutch domestic supply curve plus the minimum prices for which foreign producers are willing to offer their renewable electricity on the Dutch market. These minimum prices are the higher of the level of support they receive in their own country and their cost of production. In 2005 there will be 9 countries that meet the reciprocity criterion for export to the Netherlands<sup>73</sup>. The demand curve for the Dutch market is built up according to the structure of the ecotax as given in table 1. The 2001 level of the ecotax is assumed to be maintained till 2005. Moreover, it is assumed that there is a maximum demand of approximately 40% per consumer segment under the ecotax<sup>74</sup>. The demand curve reflects both the value of the ecotax exemption and the production subsidy. Both the demand curve and the supply curve exclude the value of the physical power, which is assumed to be traded on the conventional power market. According to the above analysis the equilibrium amount of renewable electricity consumption in the Netherlands is approximately 30 TWh. The

equilibrium price of the green value will lie around 3.6 €/kWh<sup>75</sup>.

### Implications for government expenditure

In the above analysis the contribution of domestic production to the renewable electricity market amounts to around 2 TWh of the total 30 TWh. The remaining 28 TWh is import<sup>76</sup>. The Dutch energy suppliers can purchase this electricity at a price of about 3.6 €/kWh, i.e. the equilibrium price. However, they can claim the tax benefits of the ecotax exemption plus the production subsidy, i.e. the first 15 TWh at 7.8 €/kWh and the following 15 TWh at 3.9 €/kWh. This amounts to €1.75 billion of tax revenue losses in 2005.

The 28 TWh of production that was imported to the Netherlands would also have been realised if the producers would have used their national support schemes. Therefore the additionality of this supply is at least questionable. Moreover, it can be doubted if this supply will be available for the Netherlands in the long run to meet its 2010 consumption target. In conclusion, according to the above scenario the Dutch government will lose €1.75 billion of tax revenue on 28 TWh of imported renewable electricity without any certainty as to whether this will count towards meeting its 2010 target and without providing a significant incentive to increase the level of domestic production.

### Possible policy responses for the Netherlands

Possible policy responses for the Netherlands to reduce the amount of tax losses to foreign renewable electricity production are to abolish production subsidy (36o) and to reduce the ecotax exemption (36i). For example, the ecotax exemption can be adjusted to reflect the value of the avoided CO<sub>2</sub> emissions. However, even when the ecotax exemption is lowered, in the short run there will always be a large potential of low cost renewable electricity that can be imported into the Netherlands, thus causing an outflow of tax revenues. In the long run this potential is likely to shrink as other Member States increase their policy effort to attain their 2010 renewables targets.

The above ecotax measures can be employed to restrict the problem of tax revenue losses due to imports of renewable electricity. However, they do not resolve the issue of providing investor security to stimulate domestic production. There are two principle policy instruments that are employed throughout the EU to stimulate the production of renewable electricity. These are feed-in tariffs and quota systems. Under a feed-in system producers of renewable electricity receive a fixed tariff per kWh delivered to the grid. Under a quota system producers, suppliers or consumers

<sup>72</sup> Assumptions: hydro excluded.

<sup>73</sup> By 2005 the following countries meet the reciprocity criterion: Austria, Denmark, Sweden, Norway, Finland, Belgium, Spain, Germany, and the United Kingdom.

<sup>74</sup> If the demand in any segment is lower than the assumed maximum of 40% the demand curve will shift to the left. If demand is higher than 40% the demand curve will shift to the right.

<sup>75</sup> Of course, the supply and demand curves can include uncertainties, which may cause the equilibrium price and amount to be different than elaborated in this example. However, it is likely that the equilibrium price will roughly lie between 3 and 4 €/kWh and that the equilibrium quantity will be between 15 and 30 TWh. These are broad margins, but in any case a lot of tax money is involved.

<sup>76</sup> The requirement to reserve and use import capacity on the cross-border interconnectors limits the maximum import to about 20 TWh.



of electricity are obliged to meet a certain percentage of their production, supply or demand with renewable electricity. Such a quota system can be facilitated through a tradable green certificate system as already in place in the Netherlands. Both feed-in tariffs and quota systems can be used in parallel to the ecotax incentives. Also, both can be used to provide a secure investment climate for renewable energy investors.

### **Interactions between National Renewable Electricity Support Policies**

Above some possible policy responses of the Netherlands to increase domestic renewable production and restrict tax losses were outlined. In choosing a set of policy instruments and in the design of these instruments the government also needs to take account of the developments in other Member States.

In 2003 all Member States are required to have implemented a system of guarantees of origin to authenticate the sources of renewable electricity production. The guarantees of origin will be used as a proof of compliance of the Member States with their target under the Renewables directive. Although guarantees of origin are not necessarily tradable it is likely that in many countries they will be. Certainly in the view of the market, guarantees of origin are likely to get the same status of green certificates. Moreover, several Member States have explicitly indicated the possibility to open their renewable market to imports from other Member States on the basis of reciprocal trade arrangements<sup>77</sup>. For example, Italy is currently investigating the possibilities of allowing imports of green certificates on the condition that the CO<sub>2</sub> rights attached to the certificate are imported along with the certificate. The establishment of a more standardised system of guarantees of origin throughout the EU is likely to facilitate the trade of renewable electricity between Member States. As Member States open their renewable electricity market for foreign production markets will become more directly linked. As a consequence the success of renewable energy policy is no longer only dependent on domestic policies, but also depends on the policies in other Member States. For example, depending on the value of renewable electricity in other Member States renewable electricity that is currently exported to the Netherlands may shift to a competing market (e.g. Italy) and thus no longer count for the Dutch renewables target. Thus, if imports are to play a role in the Dutch policy effort to attain the Dutch target under the Renewables directive the Dutch government must seek a fine balance of attracting sufficient imports while not unduly increasing the cost of their renewable electricity policy.

Even when markets are not directly linked there may be indirect relations between the effects of policies in different countries. For example, the Belgium region of Flanders operates a green certificate system, which does not allow the export of certificates outside Belgium. Thus, no direct international trade of green certificates from Flanders is possible. Nevertheless, an

operator of a wind park in Flanders may choose not to apply for Flemish certificates, but apply for Dutch certificates instead if the value of the green certificate is higher in the Netherlands than in Flanders. In this case part of the supply would be withdrawn from the Flemish market. This may complicate compliance in Flanders and increase the social cost due to penalty payments. Moreover, the production from this wind-park cannot be counted for Belgium target under the Renewables Directive. Similar indirect interactions can exist between countries with a feed-in system and with green certificate systems.

### **Implications for the European green certificate market and investment climate**

The case of the Netherlands illustrates the direct and indirect interactions that exist between the policy frameworks in the different Member States. In absence of a harmonised trading framework, and given the differences in support schemes between member states the value of RES varies per country according to the support mechanisms that are in place. Due to the trading of renewable electricity these differences in the value of renewable electricity affect the effectiveness of support mechanisms in the different Member States. This may cause policy makers to frequently adapt the national support frameworks in view of developments in the other Member States. Such frequent adaptation in different Member States causes a great deal of policy uncertainty-not only because the value of a project may keep changing, but also because investors are constantly reassessing which national market to target. Of course such uncertainty predominantly plays a role in the transition to a harmonised market and support framework for RES in Europe. In a completely harmonised market the price signal should be the same in each country. Thus while the transition period allowed for in the RES directive was meant to provide enough certainty to provide investors confidence in the transition to a harmonised market, the effect may be the reverse. Due to the prolonged transition adaptations in the national support policies are likely to continue which increases uncertainty.

### **The Case for harmonisation of Renewables Support Frameworks in the EU**

Whereas to date national renewable energy policy portfolios are mostly aimed at developing the national RES potential with the aim of reaching national RES targets, the liberalisation of the EU electricity markets and the RES Directive now provide the possibility to reach national targets through European trade of renewable electricity. The trading of renewable electricity across the EU exploits the benefits of varying local circumstances by first using the least expensive options available in the EU. In the REBUS project an assessment of the benefits from a harmonised EU RES trading scheme has been made (Voogt et al., 2001). REBUS demonstrated that total cost savings across the EU-15 of up to 15% can be achieved through the trading of green certificates between Member States.

<sup>77</sup> Denmark, Sweden, UK, Italy.

In addition to the significant cost savings, a harmonised market would have a single equilibrium price that would provide clear short and long-term price signals to investors to establish new plants. Moreover, the size of the combined national markets would also be an important stabilising factor as it provides enhanced flexibility for traders to sell the renewable electricity in different countries. Thus the commercial and political risk of changing market conditions in any single country is limited.

### Levels of harmonisation

Harmonisation is often associated with creating a uniform support framework for renewables. Although this can be the end point of harmonisation, there are many steps in between. By distinguishing the different steps along the harmonisation path we can get a clearer picture of what level of harmonisation is necessary to provide a stable investment climate, to meet the targets under the Renewables Directive and to safeguard a good functioning of the internal market.

In view of the targets set under the Renewables Directive, the first step of harmonisation is to provide a common framework for the registration and verification of renewable electricity that is produced. The Renewables Directive provides for such a common framework by requiring that each Member State set up a system of guarantees of origin. These guarantees of origin will “specify the energy source from which the electricity was produced...”, and “serve to enable producers of electricity from renewable energy sources to demonstrate that the electricity they sell is produced from renewable energy sources...”. Moreover, guarantees of origin are the “exclusive proof” of renewable electricity production (European Commission, 2001). Each Member State is left to implement its own system of guarantees of origin, but if necessary the Commission may propose common rules on the implementation of these systems.

Guarantees of origin need to be distinguished from tradable green certificates, as guarantees of origin are not necessarily tradable. However, based on certificates of origin tradable green certificates can be issued. In that case the associated guarantee of origin then has to be attached to the green certificate so that it cannot be used again to issue another green certificate. In the countries that have implemented a green certificate system it is likely that green certificates will also get the function of guarantees of origin. Vice versa, if guarantees of origin are allowed to be traded they will also have the function of tradable green certificates.

The next step is to base the monitoring of the Member States' progress towards reaching their 2010 renewables targets on these guarantees of origin. Member States will have to demonstrate compliance with their targets by surrendering the equivalent amount of guarantees of origin. However, in the Renewables Directive the Member State targets are specified as consumption targets. Therefore, in view of the monitoring of the targets agreements have to be made on how to account for the consumption of renewable electricity. Whatever this agreement is, monitoring of

electricity. Whatever this agreement is, monitoring of consumption should be based on guarantees of origin.

In addition to the actual consumption by final energy consumers, the use of a support scheme can also be seen as consumption. For example, when a producer surrenders a guarantee of origin to claim a feed-in tariff with a network operator this can be seen as consumption of the guarantee of origin. The network operator consequently has to transfer the guarantee of origin to a national registry where it can be counted for meeting the renewables target. Effectively all support mechanisms that target the output of renewable energy plant (e.g. feed-in tariffs, ecotax exemptions and quota) can in this respect be seen as consumption of renewable electricity and the associated guarantees of origin. Thus, the next step for harmonisation is to establish that the use of output oriented support schemes in a certain Member State counts as consumption of renewable electricity in that Member State and that this is administered through the system of guarantees of origin.

Furthermore, in relation to eligibility rules for national markets and support mechanisms it is important to set common standards for the information content of a guarantee of origin. A key requirement in this regard is that it should be clear whether a renewable energy plant has received investment support. The harmonisation of the information content becomes more important as the role of international trade in renewable electricity increases and producers have multiple support mechanisms and markets to choose from.

So far the basic steps in harmonising the verification, registration and monitoring framework for renewable electricity under the Renewables Directive have been discussed. In conjunction with the harmonisation of the rules for international trade of renewable electricity, this level of harmonisation is sufficient to facilitate international trade in renewable electricity. Such a common framework for verification, registration, monitoring and trade can co-exist along various support schemes. At the same time it provides the possibility to realise some of the benefits associated with international trade.

As alluded before, policy interactions arise from differences in the value of renewable electricity in the different Member States. This in turn is related to the differences in support levels. To avoid undesired policy interactions the level of support in the different Member States can be harmonised. Such harmonisation of the support level can first be established between countries that have a similar support framework, e.g. harmonising penalty levels between quota systems. At a later stage the support frameworks of the different groups of countries with similar policies can be harmonised with each other, until finally harmonisation is completed.

Fig. 6 outlines the different levels of harmonisation as discussed above. The necessity and level of harmonisation of the support frameworks within the EU has to be established in the light of the experiences gained with co-existing support schemes in the different Member States.



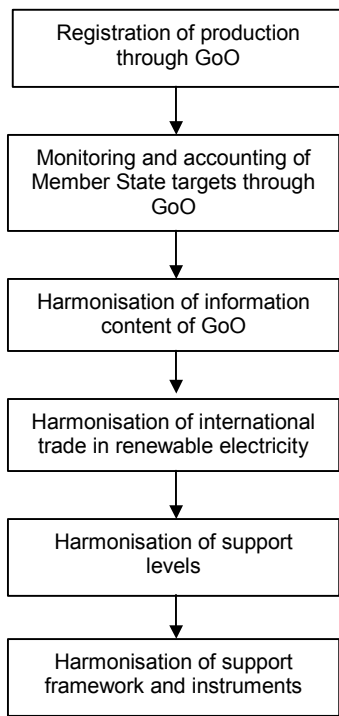


Fig. 6. Levels of harmonisation. GoO stands for Guarantees of Origin.

### The European policy challenge

The EU RES directive provides the principal legal framework for RES policy at the European and Member State level. It sets indicative targets for the penetration of RES-E for each of the Member States for the year 2010 and furthermore stipulates trigger criteria and a timeframe for the potential further harmonisation of the internal market for RES-E. A key milestone in the RES directive is the 2005 reporting duty of the Commission to the Council and the Parliament on the progress of the Member States towards meeting their indicative targets, as well as the possible interactions between the RES policy instruments in the different Member States. Based on the analysis presented in this report the Commission may – if necessary – decide to develop further initiatives to promote the penetration of renewables in EU energy mix. Such initiatives may entail mandatory Member State targets and further harmonisation of the support framework for RES-E. Recognising that by 2005 the implementation of RES projects is determined by economic and policy conditions beyond the timeframe of the RES directive, the Commission would also need a long-term strategy to underpin potential further policy initiatives.

Having different support schemes in different Member States enables the EU to review the pros and cons of the distinct national approaches to RES-E policy. Many research and evaluation projects have been carried out and many discussions have been held in which proponents were trying to convince the opponents of their preferred support schemes. These projects and discussions have led to a thorough understanding of the advantages and disadvantages of the different approaches. But what is probably more important: they show that it is not likely to expect a uniform view on

“a best support scheme” to be developed for a harmonised renewable electricity market in Europe. Most studies demonstrate that different policy instruments serve to achieve different policy goals at different administrative levels, such as fuel diversity, industrial development, employment, specific resource utilisation, greenhouse gas emissions reductions, improving local air quality and increasing the share of renewables in the generation mix.

While this diversity of policy instruments is granted in relation to the diversity of policy goals at different administrative levels, the trading of RES-E in the internal market for renewable electricity causes that these policy instruments may interact and possibly undermine each other’s effectiveness. International trade of RES-E in a non-harmonised market introduces a dependency of the value of renewable electricity on the policy conditions of other Member States. Therefore, it is likely that in the transition period towards a harmonised support framework and EU market for RES, national governments would have to make regular adjustments to the national support mechanisms in order to compensate for the effects of policy developments in other Member States. Such policy adjustments can cause an uncertain environment for investment. A harmonised support framework can create a more open and stable EU market for renewable electricity and thus provide a more stimulating environment for new investments.

In its harmonisation strategy EU should at minimum establish a common framework for the issuing, registration and consumption of guarantees of origin in relation to the monitoring of the progress of the Member States towards achieving their targets under the Renewables Directive. Furthermore, the rules for European trade in guarantees of origin or tradable green certificates should be harmonised. The ensuing steps of harmonisation consist of first harmonising the support levels and trade between Member States with similar support frameworks and then harmonising the support frameworks between all Member States. Based on experience with the efficiency and effectiveness of the coexistence of various support schemes in different Member States it will have to be decided what minimum level of harmonisation is required. The Dutch experience demonstrates that there are interactions between support mechanisms in different Member States and that these should be taken into account in designing or adjusting policy instruments. This demonstrates the need for at least some form of co-ordination. In deciding on the level of harmonisation that is necessary the benefits of harmonisation should be balanced with the benefits of pursuing more nationally oriented strategies that may be granted in order to achieve a divers set of policy goals related to renewable energy.

Finally, it is necessary to set a long-term target for the penetration of renewable electricity in the EU and to announce the policy framework in which target is to be reached. Most current renewable energy investments have a lifetime well over the timeframe of the Renewables Directive. The Renewables Directive is

thereby an insufficient framework for providing long-term certainty to investors.

### Conclusions

RES policy making at the EU level has to balance a diverse set of policy objectives and associated instruments at the local, national, regional and European level with the need to harmonise these instruments with a view to insuring the overall effectiveness of RES policy at all of these levels. The example of the Netherlands demonstrates that there is a relationship between policy developments at the various national levels, which may affect the effectiveness of national support mechanisms. The effectiveness of national renewables support mechanisms is primarily hampered by the lack of investor security as a consequence of continuously changing and interacting policy and market conditions. To provide a more stable investment climate harmonisation of national renewables support policies is necessary. Moreover, the EU should establish a long-term target for the penetration of renewable electricity in the EU electricity market, as well as the policy framework within which this target is to be achieved in order to create long-term certainty for investors.

### References

- CBS, Novem (2001), Duurzame Energie in Nederland 2000. November 2001.
- European Commission (1996), Directive 96/92/EC concerning common rules for the internal market in electricity. OJ L095, 10.04.1997.
- European Commission (2001), Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market. OJ L283/33, 27.10.2001.
- Green Certificate Body (2002), [www.groencertificatenbeheer.nl](http://www.groencertificatenbeheer.nl)
- Kroon, P. (2002), De Nederlandse Import van Duurzame Elektriciteit, een verkenning van de huidige situatie (The Dutch Import of Renewable Electricity, a survey of the current situation). ECN-C--02-063, August 2002.
- Ministry of Economic Affairs (1997), Action Programme Renewable energy in progress. The Hague, March 1997.
- Ministry of Economic Affairs (2001a), Letter to the Parliament on the Liberalisation of the green electricity market. 08.03.2001.
- Ministry of Economic Affairs (2001b), Regeling groencertificaten Elektriciteitswet 1998 (Regulation on green certificates). 7 May 2001.
- Ministry of Economic Affairs (2001c), Letter to the Parliament on the Import of renewable electricity.
- Ministry of Economic Affairs (2001d), Wijziging Regeling groencertificaten Elektriciteitswet 1998 (Amendment of the regulation on green certificates). 24 October 2001.
- Parliament (2002), Parliamentary proceedings, 28 380, nr. 43.
- Ministry of VROM (1999), Climate Policy Implementation Plan, part I (In Dutch: Uitvoeringsnota Klimaatbeleid, deel I; Binnenlandse maatregelen). June 1999.
- Platform Energy Liberalisation (2002), [www.energieliberalisering.nl](http://www.energieliberalisering.nl)
- Van Sambeek, E.J.W., et al. (2002), Green Declarations and Metering of Renewable Electricity, An investigation of competent authorities in Europe. ECN-CX--02-040, April 2002.
- Voogt, M.H., et al. (2001), Renewable energy burden sharing REBUS: effects of burden sharing and certificate trade on the renewable electricity market in Europe. ECN-C--01-030, May 2001.

## Tradable green certificates in Flanders (Belgium)

*Aviel Verbruggen & Johan Couder, UA (University of Antwerp) STEM, Antwerpen, Belgium*

**Keywords.** Green certificates; renewable energy; policy instruments

**Abstract.** The paper provides details on green certificate systems in Belgium. The Flemish region has established a system and the Walloon region is preparing a slightly different one. The lack of uniformity and consequently of transparency in one country emphasises the need for more EU leadership in the field.

The main part of the article analyses the established Flemish system. Green certificates are complementary to other instruments that promote renewable electricity, e.g. direct subventions on the feed-in price of green electricity or direct subventions on capital investments. Certificates execute a forcing effect on the actual development of green power if the imposed shares of green power in total sales are significant and if the fine level is at the height to enforce the quota. If the fine is too low the incentive effect turns into a financing tax effect. When the green certificate system does the job it is designed for, i.e. operating at the edge of the RES-E development and organise the transition from a non-sustainable to a sustainable power system, certificate prices will be high and reduce end-use consumption of electricity. A segmentation of the RES-E certificate market along the various RES-E technologies is a necessity to keep the system affordable, effective and efficient.

For harmonising the European market for green certificates and for installing the equimarginal cost principle among RES-E generators within the same technology group, one can think of two solutions. Either a single European green certificates market is established, or (yearly) optimal quotas are assigned to the various member states. Both solutions require an intensive follow-up of cost structures and of public policy measures (subventions) in all member states, but given the infant state of understanding and experience isolating regional and national markets may be best in the nearby years.

### Part I: Green Certificate Systems (proposed) in Belgium

#### *Actors responsible for energy policy in Belgium*

The situation in Belgium is complicated by the legendary institutional complexity of the country. Belgium is a federal state consisting of three regions: Flanders, Wallonia and Brussels. In Belgium 'energy' falls under the responsibility of both the federal and the regional authorities for certain matters.

The federal authorities are responsible for:

- The national equipment programme in the electricity and gas sector;
- Electricity generation (power stations);
- Electricity transmission (high-voltage lines);
- Tariffs.

The regional authorities are responsible for:

- Local transmission and distribution of electricity (under 70 kV);
- Public gas distribution;

- Cogeneration;
- Promotion of renewable energy sources (RES);
- Rational use of energy (RUE).

Flanders has introduced a green certificate system, with an obligation starting January 1st, 2002. Wallonia is about to introduce a slightly different green certificate system.

The Brussel region adopted a new electricity law in July 2001, which will come into practice in 2003.

This new law opens up the possibility for a regional certificates scheme covering the Brussels region, but it is unclear if a market system for green electricity will ever be proposed.

A separate arrangement will operate at the federal level. The federal obligation will apply to large customers directly connected to the grid. Offshore windmills don't belong to one specific region and are therefore a federal matter in Belgium. Offshore windmills will probably sell their certificates to the grid operator, who will then sell them on to distributors at whatever price he can obtain. Details have not been made official yet.

#### *Purpose of a green certificate market*

The main objective of a legally enforceable 'quota-based system' is to stimulate the penetration of a pre-defined amount of Renewable Energy Sourced Electricity (RES-E) into the electricity market.

According to the RES-E Directive (2001/77/EC), the indicative national target for RES-E for 2010 for Belgium is 6,0%.

The main characteristic of a tradable green certificate (TGC) system is the creation of a *separate* market for the "greenness" of the RES electricity, beside the market for *physical* electricity [Schaeffer 2000, p. 7]. RES-electricity is treated as any other electricity in the (physical) electricity market, and certificates are traded separately as *financial assets*. The green certificate market will function as a *financial* one. There is however a one-to-one link between the number of green certificates and the number of (physical) kWh produced by renewable technologies.

#### *General description of the TGC systems in Belgium.*

Generators of Renewable Energy Sourced Electricity (RES-E) are certified for producing RES electricity. For the production of each unit of RES electricity, they will receive a tradable green certificate (TGC) from the regional authorities [(1) in Fig. 1]. Because the certificate is unique, it is the only official proof and guarantee of a unit RES electricity having been produced.

In Flanders the regional authority will issue a TGC of 1000 kWh for each 1000 kWh RES electricity generated by the RES-E producers in their own region. In Wallonia, a green certificate will be issued for each 450 kg of CO<sub>2</sub> avoided. The RES-E producers can sell the TGCs to suppliers of electricity (wholesale power distributors) [(2) in Fig. 1].

Each producer of RES electricity thus produces two distinct goods:

- *Physical electricity*, which is fed into the grid (exported) and sold at market prices in the 'physical electricity market' [(3) in Fig. 1];
- *Tradable Green Certificates*, where each TGC represents the 'added value' or 'greenness' of one pre-defined unit of electricity produced from RES-E.

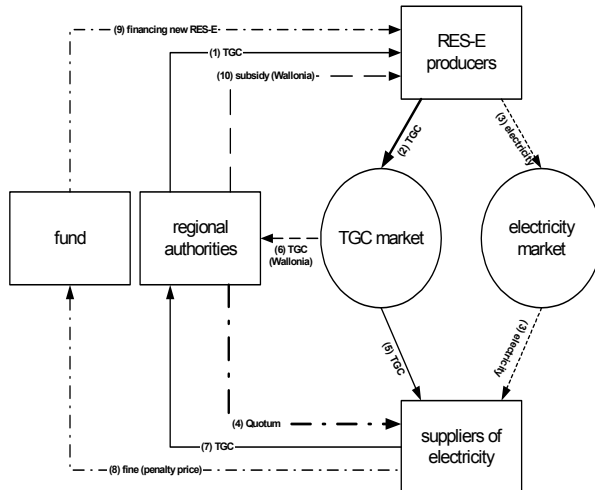


Fig. 1. Structure of the green certificate markets in Flanders and in Wallonia.

Source: CWAPE; Europese Commissie. Staatsteun nr. N 550/2000 – België Groenestroomcertificaten.

Demand for green certificates is imposed by the regional governments on the suppliers of electricity selling electricity to the end-users in their region, because they must cover a given share (quota) of electricity generated by RES-E [(4) in Fig. 1]. The quotas differ for the Flemish and Walloon regions (see Table 1).

To meet this obligation, each electricity supplier may be allowed to himself produce RES-E, or buy a specific number of TGCs from the RES-E producers, corresponding to a percentage (quota) of their total electricity supplied to the end-users during one calendar year [(5) in Fig. 1].

The government itself can also act as a buyer of green certificates, e.g. by securing a minimum price. This is only the case in the Walloon region [(6) in Fig. 1].

At the end of each year a volume of tradable green certificates corresponding to the quota will be withdrawn from the market by the regional government. Electricity suppliers have to hand over a certain amount of certificates to the regional regulating authorities [(7) in Fig. 1].

Electricity suppliers have an incentive to buy certificates from the producers, because penalties are set if they are not able to meet their obligation [(8) in Fig. 1]. The penalties differ for the Flemish and Walloon regions (see Table 1).

The penalty or fine is used for feeding a regional Renewable Energy Fund. This Fund can be used to finance new renewable installations [(9) in Fig. 1]. In the Walloon region, RES-E producers may exchange their TGCs to the regional authority for a subsidy [(10) in Fig. 1].

The Flemish and Walloon TGC systems will co-exist with other renewable energy regulations. These regulations include, for the household sector, a reduction in income taxes for investments such as the installation of solar panels for sanitary hot water production or the installation of photovoltaic panels, or the SOLTHERM program in Wallonia, providing a subsidy of 620 € for the installation of 4 m<sup>2</sup> solar panels, plus 74 € per extra m<sup>2</sup>. For the industry local authorities will continue to provide financial support for the development of renewable energy.

*Particularities of the Flemish and (proposed) Walloon green certificate markets*

See Table 1, next page.

## Part II. Economic Analysis of the Green Certificate System in Flanders

In this part of the article we hook up with the discussion on green certificates in Europe (see e.g. Mothorst 2000, Schaeffer et al. 1999, 2000, Huber et al. 2001, 2002). Most authors suggest that one has to investigate thoroughly the TGC instrument before engaging in practical experiments, and we join this argument after study of the Flemish system vested since January 1st 2002.

For the analysis it is assumed that:

- There is a liberalised "physical electricity" market, with perfect competition. The balance between electricity supply and demand determines the electricity market equilibrium price  $P_E$ . Every RES-E producer has the possibility to feed into the grid at non-discriminating conditions.
- There is a "tradable green certificate" market, with transparent price determination at a green certificate exchange. The balance between TGC supply and demand determines the TGC market equilibrium price.
- There is no international trading, and for case of simplicity we do not consider the possibility of banking certificates over the years. Therefore the analysis is mainly static.
- There is a consensus among stakeholders, including all electricity end-users, that the actual non-sustainable fossil-fuel and nuclear based power system should be phased out and replaced by a sustainable one based on renewable energy.

Our analysis takes the structure of a static supply-demand analysis.

### The Supply Side of RES-E

In the present perspective of energy sector liberalisation and of stimulating private entrepreneurs, government will not itself deploy RES-E investments<sup>78</sup> but rather expect from private investors to divert their funds to RES-E projects. In this context it is good to remember how private investors make investment decisions.

<sup>78</sup> In the 1980's the first and only wind farm in Belgium at Zeebrugge (4.5 MW) was realised by the Ministry of Infrastructure.

Table 1. Flemish and (proposed) Walloon TGC systems compared

	Flanders	Wallonia
Legal references	<ul style="list-style-type: none"> <li>- “Het decreet van 17 juli 2000 houdende de organisatie van de elektriciteitsmarkt” (B.S. 22 september 2000), a.k.a. the “Elektriciteitsdecreet”, in particular articles 21 to 25.</li> <li>- “Besluit van de Vlaamse regering van 28 september 2001 inzake de bevordering van elektriciteitsopwekking uit hernieuwbare energiebronnen”</li> </ul>	<ul style="list-style-type: none"> <li>- “Le décret du 12 avril 2001 à l’organisation du marché régional de l’électricité”.</li> <li>- Proposal “Arrêté du Gouvernement wallon relatif à la promotion de l’électricité verte”. This bill organizes the green certificates market and the promotion of green electricity in Wallonia, and has been sent to the Council of State for advice</li> </ul>
Starting date	January 1st, 2002	Not yet operational
EU competition law clearance	The EC has approved the Flemish system on July 25 <sup>th</sup> , 2001 “Steuumaatregel N 550/2000 – België”	The EC has approved the proposed Walloon system on November 28 <sup>th</sup> , 2001 “Steuumaatregel N 415/01 – België”
Obligated actors	Electricity suppliers selling electricity to end-users in the Flemish region	Electricity suppliers selling electricity to end-users in the Walloon region
Quantitative obligations (Quota)	<p>A percentage obligation in kWh supplied</p> <p>The number of certificates to be submitted for a given year is fixed according to a certain equation. For the following years, the percentage obligation coincides with the Flemish targets regarding the use of renewables:</p> <p>2002: 1,41%</p> <p>2003: 2,05%</p> <p>2004: 3%</p> <p>2010: 5%</p>	<p>A percentage obligation in kWh supplied</p> <p>1/10/2002 – 30/9/2003: 3%</p> <p>1/10/2003 – 30/9/2004: 4%</p> <p>1/10/2004 – 30/9/2005: 5%</p> <p>1/10/2005 – 30/9/2006: 6%</p> <p>1/10/2006 – 30/9/2007: 7,2%</p> <p>1/10/2007 – 30/9/2008: 8,6%</p> <p>1/10/2008 – 30/9/2009: 10,2%</p> <p>1/10/2009 – 30/9/2010: 12%</p> <p>From september 2010 onward, the quota will be multiplied annually by a factor of 1,01.</p>
Homogeneity of obligations	No technological differentiation of obligations	No technological differentiation of obligations
Issuing body	Regional regulator (public authority) VREG (Vlaamse Reguleringsinstantie voor de Elektriciteits- en Gasmarkt)	Regional regulator (public authority) CWAPE (Commission wallonne pour l’énergie)
Renewable energy technologies included	<ul style="list-style-type: none"> <li>- Solar energy (solar thermal power and photovoltaics)</li> <li>- Wind-energy (but offshore wind production falls under the federal jurisdiction)</li> <li>- Small scale hydropower (&lt; 10 MW)</li> <li>- Tidal stream energy and tidal wave energy</li> <li>- Geothermal electricity</li> <li>- Biogas from the fermentation of organic wastes</li> <li>- Animal manure, including biogas generated from animal manure</li> <li>- Biomass, including biogas generated from biomass, if not processed alongside residual wastes</li> <li>- Energy generated from: <ul style="list-style-type: none"> <li>a) Dead animals</li> <li>b) Road verge trimmings</li> <li>c) Vegetables, Fruit, and Garden waste (VFG)</li> <li>d) Separately collected or sorted organic wastes</li> <li>e) Purification sludge</li> <li>f) Frying oil used for making ‘chips’ or ‘French fries’ (the national dish in Belgium)</li> </ul> </li> </ul> <p>The Flemish region will introduce a separate certificate system for “high quality CHP”.</p>	<ul style="list-style-type: none"> <li>- Renewables, as defined in the “RES-E Directive” (European Parliament and Council, published 27 October 2001 PB L 283 27.10.2001, p. 33)</li> <li>- “High quality CHP” (certificates will be issued on the basis of avoided CO<sub>2</sub>-emissions)</li> </ul>
Technologies excluded	Residual wastes and combined processing with residual wastes	
Banking	YES	YES
Borrowing	NO	NO
Maximum price	Defined by the penalty	Defined by the penalty
Minimum price	NO	Producers of RES-E may exchange their TGC to CWAPE for a subsidy, at a fixed price of 65 € per TGC (1 TGC = 1 MWh)
Penalty for non-compliance	<p>Penalty is a fixed price per missing TGC</p> <p>2002: 50 € per missing TGC (1000 kWh)</p> <p>This fine will gradually increase to a maximum of 124 € per missing TGC</p>	<p>Penalty is a fixed price per missing TGC</p> <p>2002: 75 € per missing TGC (1000 kWh).</p> <p>From April 1<sup>st</sup> 2003 onward: 100 € per missing TGC (1000 kWh)</p>
Period of validity	<p>5 years</p> <p>TGC can only be produced for meeting the RES obligation during the year of production and five years thereafter.</p>	5 years
International trading	<ul style="list-style-type: none"> <li>- Certificates from installations outside the Flemish region plus the Belgian territorial sea, are not taken into account within the regional obligation. They may however be used to sell “green power” to end-users in the Flemish region, under the provision that the certificates are submitted to the authorities in the region where they were issued.</li> <li>- Intention to co-operate with Wallonia to make certificates exchangeable between these two regions</li> </ul>	<ul style="list-style-type: none"> <li>- Certificates will be tradable within Belgium</li> <li>- Trade with other regions or countries still to be decided.</li> </ul>

### Private Investment Decision Making Rule

Abstracting from the rules of irreversible investment decision-making under uncertainty [Dixit & Pindyck, 19..], where option values can delay the timing of projects, we refer to common Discounted Cash Flow (DCF) analysis<sup>79</sup>. An investor accepts a project when its Net Present Value is positive, or:

$$NPV(i, n) \geq 0$$

In this case the rate of return on investment at least equals  $i$ , the hurdle rate of acceptance, the net cash flows of the project being assessed over  $n$  time periods (years), or:

$$\sum_{j=0}^n \frac{Revenues(j)}{(1+i)^j} - \sum_{j=0}^n \frac{Costs(j)}{(1+i)^j} \geq 0$$

A market agent considering investing in RES-E pledges to no other rationality than any other rational market agent. But RES-E is a special product with characteristics that limit its handling in the same manner as other economic products.

### Inherent Characteristics of RES-E

RES-E projects generally exhibit the following properties (Twidell & Weir, 1986):

- The cost of the project is predominantly the capital investment cost, because it is running on free energy supplies. For simplicity, we will neglect exploitation costs.
- Capacity installed refers to a particular capacity to intercept free energy currents when available at design conditions (mostly the best ones accessible on a particular site), and to convert these currents into electricity.
- Free energy supplies are really 'free' and the investor has in most projects no discretionary impact to steer the supplies (e.g. wind, solar, run-of-the-river hydro, bio-mass when it is offered as a free source because it otherwise has to be wasted). One only can decide to bypass the free flow of energy (Twidell & Weir, 1986).
- It follows that the short-run marginal cost of RES-E is nearly zero, but that the supply is not under control. One only can throttle the free currents and spill part of it, but this is not a rational option when there is a demand for the product, as is the case when the project is connected to the power grid.
- When the renewable power can be supplied to an interconnected and competitive power system, it is worth the avoided costs of the power system, i.e. at any moment the delivered kWh is basically worth the short run marginal cost or system  $\lambda$ <sup>80</sup>.

<sup>79</sup> We also abstract from other aspects of risks as e.g. covered in Lemming 2002, p. 3-5.

<sup>80</sup> Perfect competitive power systems and perfectly planned power systems will come up with the same system  $\lambda$ 's.

When the power system works under perfect market conditions we can state that at any moment (hour or ½ hour or ¼ hour) the  $p_e = \lambda$ <sup>81</sup>.

### Profitability of RES-E under free market conditions

When the RES-E supplier can participate in the established power markets he sells all generated power at  $p_e(t), t = 1, \dots, 8760$  (hourly pricing). To assess the market revenues of the project the RES-E investor has to make the convolution of the probability density function of  $p_e(t)$  and the probability density function of  $g_r(t)$  with  $g_r(t)$  the physical output of the project at any hour  $t, t = 1, \dots, 8760$ . In principle one has to assess the convolutions for all future years of the project's life span of  $n$  years.

Simplifying one replaces

$$\iint p_e(t) \cdot g_r(t) \text{ by } \hat{p}_e(j) G_r(j) \text{ with}$$

$\hat{p}_e(j)$  expected (weighted) average price of RES-E power delivered in year  $j$

$G_r(j)$  total amount of renewable generation in year  $j$

In this setting, the investor accepts the investment when

$$NPV = \sum_{j=0}^n \frac{\hat{p}_e(j) \cdot G_r(j)}{(1+i)^j} - Investment(year0) \geq 0$$

In our present non-sustainable societies, appraisals of most RES-E project proposals with the above formula, end in a preference for other investment options above green electricity generation.

### RES-E profitability adjusted by public policy

Public policy promotes RES-E investment by private decision-makers by amending the above formula.

$$NPV = \sum_{j=0}^n \frac{\{\hat{p}_e(j) + S(j)\} \cdot G_r(j) + \hat{p}_c(j) G_r(j)}{(1+i)^j} - \{Inv - SubInv\}$$

where  $S(j)$  is a per kWh RES-E subsidy assigned in year  $j$ . This can also take the form of changing the feed-in prices  $\hat{p}_e(j)$  directly (e.g. in Belgium there is a direct support of green electricity with 2,48 €ct or 4,96 €ct/kWh), or indirectly (e.g. allowing the revolving electricity metering when PV-panels are installed).

<sup>81</sup> We do not extend the analysis to the reliability margin or congestion margin that can come on top of the system  $\lambda$  direct generation costs.

$\hat{p}_c$  is the expected price per RES-E kWh that follows from an established system of green power certificates.

SubInv is a direct investment subsidy at the time the capital investment is made (e.g. in 2001 the Flemish government covered 75% of PV investment costs).

The public policy maker therefore has at least three major direct<sup>82</sup> instruments to promote the development of RES-E. They can be applied simultaneously because they do not contravene one another.

Focusing on the green certificate system at NPV = 0, and PV[...] representing the present value of the cash flows within brackets.

$$PV \left[ \hat{p}_c(j) G_r(j) \right] = NetInvestment - PV \left[ \left\{ \hat{p}_e(j) + S(j) \right\} G_r(j) \right]$$

Assuming  $\hat{p}_c$  as the "levelised" certificate price, it follows

$$\hat{p}_c = \frac{NetInvestment}{PV[Generation]} - \frac{PV[Sales]}{PV[Generation]}$$

$$\hat{p}_c = \frac{capitalcost}{kWh} - \frac{salesrevenue}{kWh}$$

For every individual RES-E project it passes the test of profitability at NPV = 0 when the certificate price bridges the gap between (partly subsidised) capital cost and (partly subsidised) sales revenue per kWh. In a nation there exists a multitude of RES-E project opportunities. Some are realised before the

certificate system was deployed, i.e. at  $\hat{p}_c = 0$  the sales revenues could cover the capital costs. The static supply curve of RES-E is as shown by the full line in Fig. 2. By technological improvement it is expected that the costs of RES-E generation will fall (dotted curve in Fig. 2).

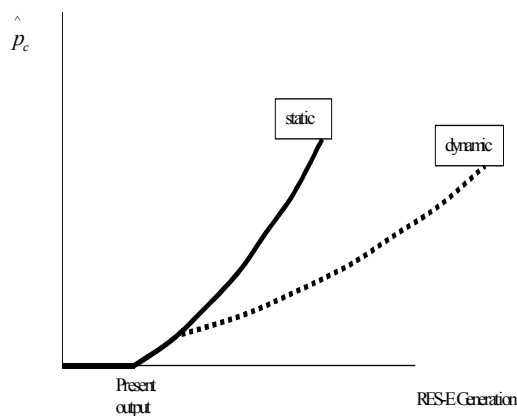


Fig. 2. The Supply Curve(s) of RES-E for given certificate prices

<sup>82</sup> More indirect instruments also can be used to promote RES-E, e.g. tax credits, soft loans, risk coverage, R & DD grants, etc.

The supply curve is the horizontal aggregation of the long-run<sup>83</sup> marginal cost curves of the numerous individual projects. Because certificates are storable (and non-perishable when banking is permitted), their trade is disconnected from the volatility of the electricity spot market. Moreover TGC-quota are not imposed as momentary obligations but as an annual aggregate. The trade in GTC therefore will be axed on RES-E capacities and their expected outputs, not on the momentary output of RES-E plants.

The actual shape and slope of the curves depend on a multitude of factors (technology, availability of sites and sources, public policy with respect to feed-in prices, direct investment subventions and other policy instruments). Therefore the curves may be very different from country to country and shift significantly over time. When comparing supply curves among countries and over time, one must look after all the "upstream" policy differences to be taken into account.

Several RES-E projects are not withheld because investors increase discount rates with (high) risk premiums due to economic and regulatory uncertainties. Also with respect to the TGC prices  $\hat{p}_c$  uncertainty may be high when the regulatory framework is unstable and when future RES-E technologies would become much cheaper than the present ones. An

expected dip in the  $\hat{p}_c$  values during some years e.g. may totally block the development of the RES-E market.

### Demand for RES-E

At the demand side for RES-E two parties are involved and connected 'in series': the end-users of electricity and the supply companies (that must meet the quota system).

### End-users

The demand of the end-users is represented by a standard down-sloping demand curve, with one point known (the present end-use at the given price) and price elasticity difficult to assess accurately.

When the supplier must process a quota of RES-E equal to  $k\%$  of his sold volume, when certificates are sold at  $\hat{p}_c$  per kWh RES-E and the full certificate price is paid by the end-users, the power price increases by  $k \hat{p}_c$ . Depending on the price elasticity of demand at  $S_0$  consumption will be reduced from  $q_0$  to  $q_n$  with some of the consumer surplus converted into support payments for RES-E (certificates or

<sup>83</sup> The relevant marginal costs are indeed the 'long-run' ones, and not the 'short-run' ones as is the case in markets with non-storable goods forthcoming from available capacities in diversified generation systems that can be composed optimally (and where in the optimum long-run and short-run costs are equal). We would compare the RES-E/GTC market with the housing market: renting prices are not equal to the short-run marginal costs of dwellings but to the long-run costs of supplying housing stock.



finer) and some social welfare loss<sup>84</sup>. The actual amounts depend on a multitude of variables ( $\hat{k}, \hat{p}_c, S_0, \mathcal{E}_0$  and the variables determining these). But under normal assumptions, consumption of electricity is lower at higher prices.

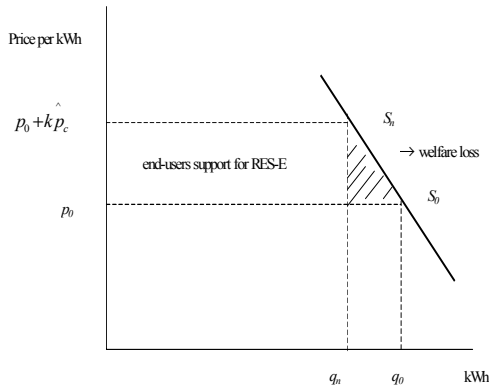


Fig. 3. End-use demand for electricity

### Power suppliers

Power suppliers must yearly deliver an amount of certificates  $kV$  with

$V$  = the sales volume of kWh

$K$  = the fraction of sales to be covered by RES-E

For every unit of  $kV$  not covered by a certificate the supplier must pay a fine  $F$  or penalty per unit.

The certificate system therefore is steered by the two parameters  $F$  and  $k$ , but also influenced by the volume  $V$ .

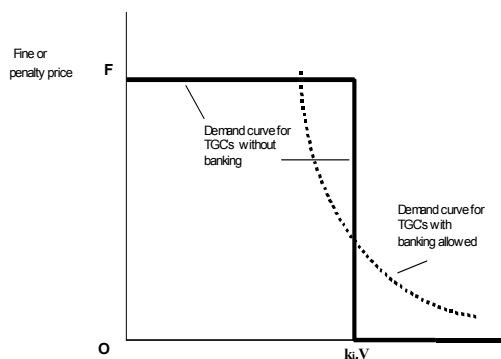


Fig. 4. Demand for GTC by suppliers

The demand curve for certificates (RES-E) by the suppliers is given by a horizontal line segment at height  $F$  up to the quantity  $k_i \cdot V$  where it changes into a vertical line segment up to the abscissa, where

<sup>84</sup> There is an argument that considers the  $\hat{k} \hat{p}_c$  price increase as the payment for transiting from the present non-sustainable system to a sustainable system. Then,  $p_0 + \hat{k} \hat{p}_c$  is the 'right' price and one is increasing social welfare (avoiding welfare losses) by installing this right price.

it becomes horizontal again at a zero price. When banking is allowed the demand curve around  $k_i \cdot V$  will be more elastic (Fig. 4).

### Equilibrium on the RES-E and certificates market

Supply of RES-E and demand for RES-E (through certificates) meet in the certificate market (Fig. 5). It is easy to verify the two  $k$ -values that bring the certificate market in a different price regime, as:

	$k < k_0$	$k_0 < k < k_f$	$k > k_f$
$\hat{p}_c =$	0	Amended Marginal cost of RES-E supplies	$F$ (fine)
Stimulus RES-E development	None	From $k_0 V$ to $k_f V$	Not further than $k_f V$
Taxing effect	None	$P_c$ plays the role of an incentive tax	Incentive and financing tax effect

The regulating authorities have to establish quota in such a way that an appropriate development of new RES-E capacity will take place [Morthorst 2000, p. 1090]. If  $k$  is set too low, the equilibrium TGC price may be too low to secure the development of new RES-E capacity at all. If  $k$  is set too high, the optimal RES-E capacity development will be lower than prescribed by the quota. The certificate price plays the role of an incentive tax when it is stimulating the

development of the RES-E market. When  $\hat{p}_c$  hits the Fine-cap it turns over in a financing tax<sup>85</sup>.

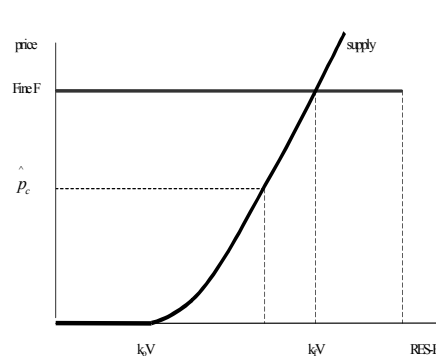


Fig. 5. Market equilibrium in the TGC-market changes with set  $k$  values

Depending on the height of the values of  $F$  and  $k$ , on the cost of RES-E supplies and on the price elasticity of demand, the green certificate system will have some impact on the end-use of power.

<sup>85</sup> Discussing environmental policy, it is argued that taxes are imposed for the pursuit of three main goals: 1) incentive taxing of target groups for undertaking or refraining from particular activities, 2) financing taxes to transfer money from target groups to public treasuries, 3) compensating taxes for making polluters pay the true costs of the (Pareto-irrelevant) externalities [Verbruggen 2002].

We have selected some parameter values<sup>86</sup> for assessing the impact of green certificate propositions. We assume a linear end-use demand curve through a market equilibrium at  $q_0 = 50$  TWh ( $10^9$  kWh) and  $p_0 = 0,10$  €/kWh, with a price elasticity of demand  $\varepsilon$  at 0,4. We consider three types of RES-E technologies: mature ones (e.g. wind-power), at arms-length ones (e.g. bio-mass) and distant ones (e.g. photo-voltaic power). The supply curve of RES-E certificates is given by stepwise linear segments, starting at an RES-E output of 400 GWh, and with a slope of respectively 0,5, 0,75 and 1,0 E-10 €/kWh<sup>2</sup>. The TGC supply curve is shown in Fig. 6.

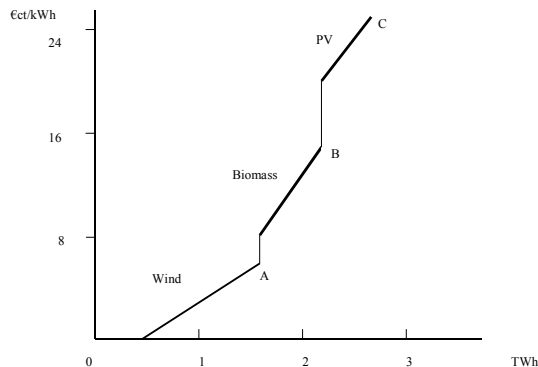


Fig. 6. TGC supply curve (Flanders)

TGC can force the RES-E technologies into the market. Every costlier technology requires a forcer forcing power of the quota-fine pair.

To bring the first group of RES-E projects based on the least-cost options (represented by 'Wind-power') fully in the market a 3.3% quota is required with a forcing fine of at least<sup>87</sup> 7 €/ct/kWh. The impact on end-user is small and welfare losses negligible. The picture changes totally when less available and more costly RES-E options have to be addressed to meet the quota (see Table 2).

If a single certificate price is applied, this price must step up enormously to bring the marginal technology in the market. It creates a significant price effect (and demand reduction) and it transfers large amounts of cash from the end-users to the RES-E generators. Some of this transfer is required to cover part of the RES-E costs, but an increasing share is rents received by the sub-marginal RES-E generators. While rents within the same technology group are acceptable (and comparable to the working of other markets), the technology diversity amalgamated under the common heading of RES-E creates windfall profits for the mature technologies. In the example, situation B means that 40% of the payments by end-users are windfall profits to wind-power investors, while in situation C even 54% of the payments are windfall profits acquired by (mainly) wind-power and by bio-mass RES-E generators. The weight of

the TGC-system on the end-users will also grow to unacceptable burdens. The high TGC-prices will significantly increase the end-use electricity price (e.g. by 1.45 €/ct/kWh in point C). At a price elasticity of end-use demand of 0.4 the reduced end-use demand would be larger than the generation of RES-E.

Table 2. Forcing RES-E with the TGC system (non-segmented market; single target and price)

	Wind-power (point A)	Bio-mass (point B)	Photo-voltaic (point C)
Quota (% supplies)	3,3	5	6
Quota forcing Fine (€/kWh)	7	16	25
Certificate price (€/kWh)	6,18	15,18	24,25
End-use power reduction (TWh)	0,408	1,518	2,910
RES-E generation (TWh)	1,637	2,424	2,825
Certificate revenues (M€)	101	368	685
Cost coverage (M€)			
• Wind-power	38	38	38
• Bio-mass	-	96	96
• PV	-	-	89
Producer surplus (M€)			
• Wind-power	63	210	359
• Bio-mass	-	23	95
• PV	-	-	8
Windfall profits (M€)	-	147	367

It is evident that forcing the 'distant' RES-E technology into the market through a single quota-fine (k, F) pair creates a lot of bias. The less distant technologies reap significant windfall profits, simply by freeriding on the system. It makes the system very expensive and it would loose all credibility with the end-users that have to pay the bills. This point was addressed extensively by Huber, et al. (2001, 2002).

For reducing the windfall surpluses they suggest to limit the validity of certificate rights in time (e.g. a RES-E plant built in 2000 can sell rights only until 2010). We believe this regulation will be administratively difficult to follow up (e.g. when 'some' retrofitting on the above plant occurs in 2008), and it does not solve the issue of the diversity in technologies.

As did Schaeffer (2000) in general, we propose to segment the certificates market by technology (group), e.g. wind-power, hydro, biomass, and E-solar in Flanders. For every technology group  $t$  one has to study in detail the TGC-supply curve and to find the  $(k_j^t, F_j^t)$  pairs that help to force the target market development of the technology over time (years  $j = 1 \dots n$ ).

The electricity suppliers are subjected to a quota for every technology. This makes the TGC market segments thinner, but the system is more transparent and feasible (affordable, acceptable by electricity end-users). Assuming the same parameter values as above, we have repeated the calculations for a segmented TGC-market, where the three technologies are introduced consecutively for meeting the same 6% target as in the previous example and where the present RES-E generation is considered to be wind-

<sup>86</sup> The values are not based on an in-depth analysis of the real situation in Flanders.

<sup>87</sup> The fine set in practice is best a little bit higher than the marginal forcing fine to keep the GTC market lively.

power. Results are shown in Table 3, contrasting with the numbers of Table 2.

Table 3. Forcing RES-E with the TGC system (add-on segmented markets; technology specific targets and prices)

	Wind-power (point A)	Bio-mass (point B)	Photo-voltaïc (point C)	Total
Quota (% supplies)	3,3	+1,7	+1,0	6
Quota forcing Fine (€ct/kWh)	7	16	26	
Certificate price (€ct/kWh)	6,18	15,54	25,57	
End-use power reduction (TWh)	0,408	0,513	0,479	1,400
RES-E generation (TWh)	1,637	0,834	0,486	2,957
Certificate revenues (M€)	101	129	124	354
Cost coverage (M€)	38	103	112	253
Producer surplus (M€)	63	26	12	101
Windfall profits (M€)	-	-	-	-

Because windfall profits among technologies are excluded, the cost of the system is much lower. In every technology segment there remain some producer surpluses, but this can create a stimulus for further technological development that will lower costs. The impact on end-use is smaller. The electricity price is increased three times but in smaller steps and overall with 1.1 ct/kWh. This has an impact in less on consumption of 1.4 TWh. Because this impact is smaller and the aggregate quota is kept at 6% of sales volumes, the RES-E output is about 132 GWh larger than in the previous case.

Our analysis does not match the conclusions by Jensen and Skytte (2002) on the ambiguous effects of TGC's on the price and consumption of electricity. Our TGC supply curve is an amended marginal cost curve net of subsidies and receipts by selling the electricity in the market. When the price of the latter decreases, the supply curve of TGC will shift to the left, and the higher electricity prices to the end-users will remain unaffected<sup>88</sup>. Higher prices will reduce demand. Our conclusion is that TGC as an instrument to force RES-E generation into the market goes hand in hand with higher end-use prices that will stimulate electricity savings. When the RES-E targets are set bullish, the fine levels have to be fixed at heights that society considers unacceptable today. The fines and the forthcoming certificate prices are really functioning as an incentive and financing tax.

### Evaluation of the Flemish TGC market system

It is early days yet to evaluate the performance of the Flemish TGC market system. By April first 2002, 13 RES-E producers had been officially recognised in

the Flemish region. From July 1<sup>st</sup> onward TGCs are registered and monitored as electronic records in a central Internet-based database (before that date TGCs were *paper* certificates). End of June 2002 (6 months after the introduction of the TGC market system), only one supplier and 3 potential buyers of TGCs have made themselves known to the Flemish regulating authority VREG. As far as we know, no actual trade of TGCs has yet taken place. VREG has the legal obligation to publish the amount of certificates for sale, and the average price of a TGC on a monthly basis. As of July 1<sup>st</sup> 2002, the website of the VREG has not made public any information on traded volume or prices

(<http://www.vreg.be/groenestroomcertificaten.htm>).

The low number of suppliers and potential buyers of TGCs so far may in part be due to electricity suppliers in Flanders producing the own RES-E to meet the low 2002-quota (1,41% of sales), and partly to the "thinness" of the present Flemish electricity market.

Our analysis suggests as policy conclusions:

1. TGC is a very effective instrument. It can also be made very efficient when it is handled with foresight and care. Particular attention is needed for segmenting the certificate market along RES-E technologies with common cost properties, and for estimating RES-E cost functions and their development over time. Also the setting of the parameters  $k$  = quota % of RES-E in total supplies and of  $F$  = fine per kWh shortfall to the quota for the various technologies and for the years to come, needs careful consideration.
2. TGC is not conflicting with other instruments supporting RES-E development. TGC can be handled as the instrument that is complementary to the other supports, and that forces the development of RES-E in the market along the potentials and the targets set forward. TGC must be matched to the impact of other instruments, in particular direct kWh support for RES-E (e.g. through improved feed-in conditions) and capital subsidies.
3. TGC's and in particular also the installed fines (price caps of TGC's) exercise a taxing effect on electricity end-use. Final demand will be choked by the higher power prices following the payment for TGC quota by the suppliers. The overall effect depends on the elasticity of demand and on the cost of RES-E technologies. The welfare losses remain small, but the payments by end-users for the development of RES-E become a visible share of their bills.
4. If the diversity in technologies and their cost realities are not recognised and the certificates market is not segmented, the taxing effect of the TGC system becomes very important when the system wants to function at the edge of the marginal RES-E technology. A large share of the tax money would be collected as windfall profits by the investors in mature RES-E solutions<sup>89</sup>. The

<sup>88</sup> In the end-user price  $P_e + k.P_c$ , the decrease in  $P_e$  will be evenly compensated by an increase in the  $k.P_c$  term due to raising  $P_c$  values.

<sup>89</sup> After weeks of discussion in Flanders it was decided not to include the combustion of municipal solid waste as a RES-E

- payments by end-users would grow so high that the system would implode under its own weight.
5. The crucial key for RES-E to penetrate is and remains (of course) the technical and economic performance of the various RES-E technologies. TGC is very effective to force their development to the edge, but over the edge it becomes mainly a taxing instrument that stimulates end-users to energy efficiency and that creates funds to develop RES-E solutions. R&DD to develop renewable technologies to enhance reach and to lower cost remains therefore the most important policy instrument.
  6. Efficiency within a given region, nation or union (EU) is reached when marginal costs of RES-E supplies are equated. In principle, there are two ways to reach this bliss situation. On the one hand, the EU can install a single TGC market. This requires unified market clearing systems, and a firm control on the TGC supply functions to harmonise for subvention mechanisms other than TGC's. On the other hand, the EU can organise an optimal system of RES-E quota per technology and per nation, equating through the assigned quota the marginal costs of RES-E generation per technology all over the EU. Because the TGC is such a flexible instrument, the fines can be tuned to spur suppliers to attain the set quota. Both approaches require sophisticated and reliable information on the RES-E cost functions and their future development possibilities in the various participating nations.
  7. Through the instrument of green certificates public policy can force the transition of a non-sustainable energy system to a sustainable one finally based on renewable energy. It can make the energy consumers pay for this costly transition, but it should safeguard that payments are always kept as low as possible, because the transition is a very costly operation. Intensive study and a broad societal debate are required to decide on the pace of the transition and on the way burdens are allocated among classes of end-users.

## References

- Het besluit van de Vlaamse regering van 28 september 2001 inzake de bevordering van elektriciteitsopwekking uit hernieuwbare energiebronnen (B.S. 23 oktober 2001).
- Directive 2001/77/EC of the European Parliament and of the council of 27 september 2001 on the promotion of electricity from renewable energy sources in the internal electricity market.
- Elektriciteitsdecreet. Het decreet van 17 juli 2000 houdende de organisatie van de elektriciteitsmarkt (B.S. 22 september 2000).
- Europese Commissie. Staatssteun N 415/A/01 – België Ontwerpdecreet van de Waalse regering betreffende de bevordering van groene stroom – Aspecten betreffende het systeem van groenestroomcertificaten

- Europese Commissie. Staatssteun nr. N 550/2000 – België Groenestroomcertificaten.
- Le décret du 12 avril 2001 à l'organisation du marché régional de l'électricité.
- Huber, C. et al.: *Final Report of the project ElGreen (Organising a Joint European Green Electricity Market)*, Energy Economics Group (EEG), Institute of Power Systems and Energy Economics, Vienna University of Technology, Austria, November 2001.
- Huber, C., Faber T., Haas R., Resch G., 'Tradable Green Certificates or Feed-in Tariffs?', 3<sup>rd</sup> ENER Forum, Budapest, June 6-7, 2002.
- Jensen, S. G. and Skytte, K.: *Interactions between the power and green certificate markets*, in: *Energy Policy* 30 (2002), pp. 425-435.
- Lemming, Jacob: *Financial Risks for Green Electricity Investors and Producers in a Tradable Green Certificate Market*, Working paper (February 2002), Systems Analysis Department, Risø National Laboratory, Roskilde, 2002.
- Morthorst, P.E.: *The development of a green certificate market*, in: *Energy Policy* 28 (2000), pp. 1085-1094.
- Projet d'arrêté du Gouvernement wallon relatif à la promotion de l'électricité verte.
- Schaeffer, G.J. et al., *The Implications of Tradable Green Certificates for the Deployment of Renewable Electricity*, Mid-Term Report, ECN-C—99-072, ECN, October 1999.
- Schaeffer, G.J. et al., *Options for design of tradable green certificate systems*, ECN-C—00-32, ECN, April 2000.
- Twidell J, Weir T., Renewable Energy Resources, E&FN Spon, UK, 1986
- Verbruggen A., Milieueffingen en milieuschulden: waarover praten we?, *Economisch en Sociaal Tijdschrift* 56 (2002), pp. 33-59.
- Wet van 29 april 1999 betreffende de organisatie van de elektriciteitsmarkt (Belgisch Staatsblad van 11 mei 1999).

---

source. If the outcome of this debate had been otherwise, this technology would have been the first beneficiary of windfall profits when the certificate price would start its climb.

## The Challenge for Tradable Green Certificates in the UK<sup>90</sup>

Adrian Smith and Jim Watson, SPRU, University of Sussex, UK<sup>91</sup>.

**Keywords.** Renewable energy; Tradable green certificates; Innovation; Policy package.

### Abstract.

This paper introduces the tradable green certificates policy instrument that has been introduced in the UK. The Renewables Obligation, as it is known, provides a welcome boost for renewables. However, if the policy target of a three-fold expansion in renewable capacity is to be met by 2010, complementary policy measures will be needed in areas such as land use planning, the wholesale electricity market, and network access. Moreover, while the Renewables Obligation may be suitable for more mature technologies (e.g. wind), it may not provide the long-term support needed to diffuse the next generation of renewable technologies. Further development of innovation policy is required to address this issue.

### Introduction

In May 2002, the UK's renewable energy industry received a new lease of life. The introduction of the new Renewables Obligation (DTI 2001) marks the next stage in the government's plan to meet 10% of our electricity needs from renewables by 2010.<sup>92</sup> This aim, a commitment since Labour were voted into government in 1997, is an ambitious one. Although renewable energy sources such as wind and small hydro have received public support for many years, progress has been slow.

The Renewables Obligation represents an opportunity for renewables in the UK to live up to their promise. It replaces a 'bidding' policy framework that had been in place for a decade: the Non-Fossil Fuel Obligation (NFFO). Renewables currently supply just under 3% of UK electricity (see Table 1), a slight improvement on the level when NFFO was introduced in 1990, which was just under 2%. Of the 10.48 TWh of renewably generated electricity in 2000, 46.5 % came from large scale hydro (mostly located in Scotland). Table 1 provides details for the growth in renewable electricity generation in recent years.

The NFFO competitive bidding process led to some renewables projects bidding too low which, coupled with a challenging planning environment, meant that some projects selected for NFFO support have not been constructed.

This paper presents a prospective commentary on the Renewables Obligation. Its aim is to introduce the

new policy and then sketch out some of the challenges that lie ahead in meeting the 2010 target – from the electricity market, the planning system, established modes of energy regulation, and innovating in new renewable technologies.

### The Renewables Obligation

The Renewables Obligation creates a new England and Wales market in tradable green certificates, known in the UK as Renewables Obligation Certificates. A similar, but separate system has been created for Scotland whose operation is broadly the same. Renewables Obligation Certificates (or ROCs) will have to be produced by every energy supplier to prove that they have sourced a set percentage of their electricity from renewables. This percentage starts at 3% for 2002/03 and rises gradually to 10.4% for 2010/11 and subsequent years (House of Commons 2002). According to the details of the policy drawn up by the Department of Trade and Industry, these suppliers can meet their obligation in three ways:

- By producing ROCs to show that they have generated or bought electricity from recognised renewable energy generators.
- By buying ROCs on the open market from other suppliers with a surplus.
- By paying the 'buyout price' of 3p per unit (kWh) to make up the shortfall between their stock of ROCs and their statutory target. Buyout price receipts will be recycled back to suppliers in proportion to their holdings of ROCs.

As a result of this new policy, renewable energy generators will now earn revenue from two markets: the electricity market and a separate market in ROCs. The assumption is that this should give renewables an extra revenue boost by adding a subsidy of up to 3p/kWh to the wholesale market price of electricity (which is currently around 1.6p/kWh).

### How the Market Should Work

As Figure 1 shows, the operation of a tradable green certificate market such as that designed to meet the Renewables Obligation is *theoretically* simple (Morthorst 2000). As the supply curve *S* illustrates, when the price of ROCs rises, more and more developers will be encouraged to build renewable energy generation capacity. Moreover, market mechanisms introduce competition between renewables generators for ROC revenues. This is to the advantage of cost competitive generators and encourages others to follow suit.

By including a fixed 'buyout price' for suppliers, the UK scheme places a boundary on the operation of the ROC market. If the target for renewable energy supply is modest (represented by demand-line  $T_{Mod}$ ), generators of renewable electricity will sell ROCs at price  $P_M$ . If, however, the government sets a more ambitious target in the future ( $T_{Amb}$ ) such that the price for ROCs climbs above the Buyout Price to  $P_A$ , then not all of that obliged demand will be met. Only generators that can profit below or at the Buyout

<sup>90</sup> An earlier version of this paper appeared as a Tyndall Briefing Paper – see <http://www.tyndall.ac.uk/>

<sup>91</sup> SPRU, Mantell Building, University of Sussex, Falmer, East Sussex, BN1 9RF. Tel 01273 873539. [w.j.watson@sussex.ac.uk](mailto:w.j.watson@sussex.ac.uk); [a.g.smith@sussex.ac.uk](mailto:a.g.smith@sussex.ac.uk)

<sup>92</sup> Under the DTI Energy Paper 68 medium economic growth scenario, the 10 per cent target implies at least 37.1 TWh of electricity by 2010 (1 TWh = 1 thousand million kWh or 10 thousand million 100W lightbulbs switched on for one hour).

Price will meet demand. In this way, an upper financial limit is imposed on support for renewables expansion.

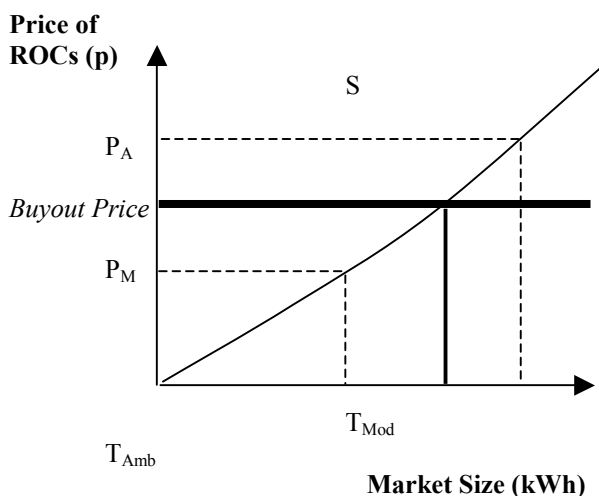


Fig. 1. An Ideal Market in Renewables Obligation Certificates

This simple supply-demand analysis underpins the Renewables Obligation policy instrument. While useful heuristically, the analysis does not capture many of the factors that will determine the expansion of UK renewables in practice. After only a few months of operation, it is difficult to predict how much the real market will differ from the theoretical model. However, there are signs that the market is already responding to an initial shortage of renewables capacity.

Whilst the Renewables Obligation only requires suppliers to source 3% of their electricity from renewables in 2002/03, ROC prices have already been pushed above the artificial ceiling of 3p/kWh (Steen 2002). The inflation in ROC prices is partly due to renewable electricity benefiting from an exemption from the Climate Change Levy charged to the business use of energy. This exemption is worth 0.43p/kWh. More importantly, ROC prices are also high because the eligibility rules for the Renewables Obligation exclude some operational renewables schemes (particularly large hydro plants). There is high demand for ROCs from electricity suppliers who wish to maximise their share of recycled 'buyout' proceeds.

Table 1: Renewable Electricity Generation in the UK, (GWh).

	1996	1997	1998	1999	2000
Onshore wind	488	667	877	850	946
Solar photovoltaics	-	-	-	1	1
Hydro:					
Small scale	118	164	206	232	239
Large scale	3275	4005	4911	5128	4869
Biofuels:					
Landfill gas	708	918	1185	1703	2188
Sewage sludge digestion	410	408	386	410	366
MSW combustion	777	929	1348	1359	1368
Other (e.g. farm waste, tyres)	326	338	318	515	499
<b>Renewables Total</b>	<b>6101</b>	<b>7428</b>	<b>9231</b>	<b>10199</b>	<b>10476</b>
<b>Percentage of Total Generation</b>	<b>1.7%</b>	<b>2.1%</b>	<b>2.5%</b>	<b>2.8%</b>	<b>2.8%</b>

Source: Department of Trade and Industry, 2002.

A recent analysis of possible UK renewable energy deployment to 2020 indicates that the average value of ROCs is likely to be 3.4-5.7p/kWh in 2002/03<sup>93</sup>. Under some scenarios, it is expected that this value will continue rising in subsequent years due to slow renewable energy deployment rates. Under others, the price will fall again towards 3.0p/kWh as deployment expands rapidly. The financial implications for electricity suppliers with renewables are mixed – on the positive side, they might have a substantial revenue boost from high ROC prices. On the negative side, this boost may be short-lived and heavily discounted by financiers of new projects on the grounds that many new projects will be brought forward quickly.

Despite the initial evidence that the price signal from ROCs is operating as planned, the future of renewables deployment is clouded by considerable uncertainty. Whilst the market in ROCs will create a positive financial signal for promoting renewables, it is only one signal amongst a host of others. Technological, regulatory and planning issues will shape the real ROC supply curve, perhaps in complex and unanticipated ways. The remainder of this paper introduces some of the challenges confronting the government's plan to more than triple renewables capacity in the UK by 2010. These challenges are:

- The process of obtaining planning permission for new renewables projects, particularly wind.
- Recent reforms to the rules and operation of the wholesale electricity market that favour incumbent fossil-fuel generators over renewables generators.

<sup>93</sup> Based on four socio-economic scenarios for renewables deployment to 2020 (Watson 2002), assuming simplified deployment rates.



- Technical and institutional problems in connecting renewables to electricity networks.
- Whether ROCs will stimulate innovation across a range of 'next generation' renewables technologies that will be needed to move beyond the 10 per cent target in the longer-term.

A coherent set of policies working across all these fronts is important not just for meeting the 10 per cent target but also for building a solid foundation for further expansion beyond 2010.

### Planning Difficulties

The difficulty of obtaining planning permission – particularly for wind energy schemes – has presented a major barrier to renewables expansion over the past decade. Difficulties with the NFFO can be partly attributed to protracted planning disputes. The government has been relatively sanguine about the rate of success amongst renewables planning applications. Under the successive 'orders' of the NFFO scheme, only 11 per cent of the third order projects were refused planning permission, and six per cent of the fourth order were also refused. By 1999, 18 per cent of third order projects had not applied for planning permission, and 46 per cent of the fourth order projects had not yet done so. The fourth order projects were given the green light and assured price supports in 1997 (ENDS 1999). Many renewables projects have been going ahead – but not all of them.

The above data relates to numbers of *projects* rather than renewable generating *capacity* installed. The majority of these projects have generated electricity from landfill gas.<sup>94</sup> Analysis by the Confederation of Renewable Energy Associations excluded landfill gas projects and focused instead on total generating capacity from other renewables. CREA claims that only 855MW of a total renewables capacity of 3638MW had obtained planning permission by 2000 (Hartnell 2001). This represents only 23 per cent of all renewable capacity supported under the old NFFO system, excluding landfill gas). The picture is complicated by project commissioning rules under the old NFFO system – some NFFO projects bid too low and never went ahead on commercial grounds. However, it is clear that other projects are finding it difficult to get planning permission, particularly wind power (Mitchell 2000).

In response to planning bottlenecks, the government is requiring each English region to set strategic renewable targets for 2010 (similar to the traditional setting of strategic targets for housing). These targets are expected to cascade down into the structure plans and local plans of local authorities and become a material consideration in local planning decisions. This will take several years to achieve. The targets set by the regions will, at best, just meet the national target of 10 per cent, and at worst fall short by 3.5 percentage points (OXERA and ARUP 2002). The government is currently seeking to streamline the planning process for

certain types of development, which could include renewables projects. However, there is a risk that such top-down imposition of renewables upon local communities, under a planning process reduced in local democratic content, could dent opinion towards sustainable energy. Complementary mechanisms that build support from the community-level upwards might be explored. These include designing renewable developments such that they give local communities a direct financial stake in the benefits (e.g. a share of the profits or reduced electricity bills), and policies that educate and bring home the environmental consequences of our energy use (such as a carbon tax).

### Facing up to NETA

Planning difficulties have recently been compounded by a number of market and regulatory barriers to renewables deployment. Perhaps the largest challenge of all is posed by the reformed electricity trading market, known as NETA (the New Electricity Trading Arrangements). NETA was launched in April 2001. It was designed to correct perceived imperfections in the wholesale electricity market, and lower prices.

So far, NETA has delivered on this overall promise – prices have fallen significantly. However, there are concerns with some of its side effects. From the start of the reform process, the Department of Trade and Industry (DTI) was keen to point out that NETA should be designed to promote the use of renewable energy sources (DTI 1998). Unfortunately for the renewables industry, this has not happened in practice. Renewable energy sources have fallen foul of NETA's in-built preference for predictable sources of generation. This can leave intermittent sources of generation (such as wind power) at a relative cost disadvantage under NETA.<sup>95</sup>

Is NETA standing in the way of the government's renewables expansion plans; and, if so, what can be done to help? The utilities regulator OFGEM, which was jointly responsible for NETA with the DTI, has shown little willingness to entertain further modifications to the market. A review of the first three months of NETA acknowledged the problem, but felt that it was a minor issue when compared with the general record of electricity price reductions (OFGEM 2001). A further review of NETA's first year is now underway. Moves to try to help renewable generators have focused on the development of consolidation services to spread the risk of unpredictability across larger numbers of renewables plants. The renewables industry is unhappy with this solution, and consolidation arrangements have been proceeding slowly (ENDS 2002).

It remains to be seen whether the consolidation approach will be successful in preventing NETA penalising intermittent renewables. Investors in new intermittent renewables technologies will have to consider

<sup>94</sup> Under the fifth NFFO order (1998) 68 per cent of new capacity will come from landfill gas projects, and 29 per cent from onshore wind projects.

<sup>95</sup> There is also evidence to suggest NETA is placing operational pressure on the combined heat and power industry and larger gas-fired power stations, who are already suffering under high gas prices - Green 2001; author's conversations with operators of gas-fired CCGT power plants

consolidation if they do not wish to be at a disadvantage under NETA. OFGEM and DTI must continue to monitor the performance of NETA and the new consolidation arrangements, and be open to further reforms if necessary. The Utilities Act 2000 provides government with the scope to do this. The Act allows government to develop social and environmental guidance which should be taken into account as OFGEM conducts its business. The draft guidance published in May 2001 makes reference to the UK Climate Change Programme which includes the 2010 renewables target. It states that 'the Government invites [OFGEM] to seek to exercise its functions in a way consistent with the objectives set out in this [Programme]' (DTI 2001).

### Regulating for Embedded Generation

Whilst NETA may not be good news for renewables, at least in the short term, a move to cost reflective charges for the use of electricity distribution networks certainly could work in their favour. If small renewables plants are embedded within distribution networks at particular locations, their economic value to the electricity system can be substantial. This value largely stems from the avoided cost of reinforcements to the distribution and, ultimately, the high voltage transmission system.

At present, the charging structure for connection to the UK electricity distribution system and for using it to export power is not particularly sophisticated. As a result, smaller generators are unable to capture the value they bring to the system as a whole. Instead they are often penalised by electricity distribution companies because the networks are designed for the traditional transmission of power from large generators down to consumers. An embedded generator wishing to connect to the distribution system is expected to pay the costs in full, including any upstream reinforcements to the transmission system. Not surprisingly, this can be expensive for proposed renewables schemes. The revenue support from ROCs will need to offset these network charges.

Embedded generation could be promoted further under a shift towards more 'active' distribution networks designed to balance large numbers of small generators as well as transmitting power in bulk. This shift requires substantial investment enabled by a more cost-reflective charging structure for the use of distribution wires. Distribution companies need to be able to make the necessary infrastructure investments – investments which would currently fall foul of OFGEM's rules because they are not seen as 'essential' to current operations. In short, distribution companies currently have little incentive to promote embedded generation from renewables.

The need for reform has recently started to attract some government and regulatory interest. A joint DTI/OFGEM working group on embedded generation produced a report in January 2001 (OFGEM/DTI 2001) which set out options for new charging structures. The successor to this group is continuing to work on the issue. As with NETA, there is considerable debate about the merits of altering the charging struc-

ture for distribution wires, and some reluctance to change a system that has delivered price reductions to consumers.

### Stimulating Innovation

The Renewables Obligation targets and the associated market in ROCs will give investors in renewable technology an additional revenue stream to recover costs. Yet, as we have illustrated in this paper, the renewables investor still faces considerable supply-side uncertainties besides the operation of the ROC market. Ultimately, moving beyond the 10 per cent renewables target, possibly to meet a longer term target of 20 per cent by 2020 (PIU 2002), will require significant innovation in our electricity supply systems.

The Renewables Obligation does not distinguish between renewables technologies. The ROC market requires all renewables technologies to compete against the standard of the incumbent market leader. This means that promising 'next generation' technologies, such as wave power or photovoltaics, will have to compete against the cheaper technologies, such as on-shore wind power and energy-from-waste (which, incidentally, both court planning controversy). The single market in renewables may not prove to support the longer-term innovation of a range of new renewables technologies. The experience of NFFO was that competitive support for renewables did not nurture a renewables industry in the UK. Ironically, developers imported the cheapest renewables technology from countries such as Denmark and Germany that had developed a vibrant domestic renewables industry under different systems of support (Mitchell 2000).

Studies into past transformations in energy systems have noted just how uncertain the transformation process was in its early stages, that interconnected innovations in many new technologies were required, and that some of these proved to be dead-ends (Hughes 1987). Many innovation experts in academia and government recognise the value of investment in diverse portfolios of new technologies as a means of stimulating innovation, building up skills and capabilities, and insuring against the risk of locking into sub-optimal technological dead-ends (Kemp et al, 1998; Anderson and Jacobsson 2000). Promoting systems innovation implies economic 'waste' - in the sense that certain experiments will fail to become viable technologies yet will still create valuable new knowledge (Grabher and Stark 1997). Encouraging investors to take such risks will mean offering them higher potential returns on their investment (compared to other, less risky money-making opportunities). Moreover, stimulating innovation and the growth of new industries is a long-term endeavour.<sup>96</sup>

There is hope in the UK in the form of government capital grants support for demonstration projects in these less developed renewable technologies. The government has promised £260 million over the next

<sup>96</sup> The German wind-turbine sector became successful after 10 years of nurturing (Johnson and Jacobsson).

three years, primarily for offshore wind and energy crops, and with a little support for photovoltaics, wave and tidal power (Chief Scientific Adviser 2002). This capital funding must link to the assured revenues needed if a portfolio of renewable technologies is to seriously displace incumbent fossil-fuel and nuclear electricity generation. Will support for demonstrations include market formation (i.e. deployment) activities for successfully demonstrated new technologies? Market formation is a vital bridge between the demonstration projects and the entry of commercial investors.

### Will the New Policy Deliver ?

It is clear that the Renewables Obligation represents an opportunity for renewable energy to gain a foothold in the UK. However, despite the level of financial support the Renewables Obligation might bring to renewables, the UK will struggle to achieve the 10% government target by 2010.

Looking further ahead, the Renewables Obligation is only a first step. On its own, we should not expect this policy to deliver a break from past trends and deliver a transformation in our electricity supply system. A portfolio of competitive renewable technologies is not sitting waiting to be taken off the shelf, plugged-in and put to use like a new washing machine. If the UK wishes to displace a significant proportion of the incumbent system of large, centralised, fossil-fuel and nuclear electricity generation with renewables, then it will need a range of well-developed renewables technologies. Even when sufficiently well developed, any expansion in renewables technology will have to interact with planning processes, electricity markets, and transmission issues.

A renewables policy package must address various barriers and challenges: Electricity markets must be sensitive to the intermittent nature of some renewable generating technologies. The value of embedded generation in local distribution networks must be rewarded. Planning controls exist for good reason, to control land use and protect public amenity, and any policy to greatly expand renewable technologies will have to work with local communities if that expansion is to proceed smoothly. Most critically, innovation policy must stimulate a diverse range of renewable technologies and niche market formation initiatives. In pursuing this goal, policy-makers must recognise that this is a long-term activity.

Within the context of innovation policy, debates about a 'universal' best support mechanism for renewables seem misplaced. A sensible policy and research agenda would not ask whether green certificate policies such as the Renewables Obligation are better than the feed-in tariffs in place in some EU countries (e.g. Germany). Rather, there is a need explore which combinations of policy instruments best help a range of renewable technologies in different national contexts. This should take into account the different stages of development of various renewables together with country-specific institutional, market and resource conditions.

### References

- Andersson, B.A. and Jacobsson S. (2000) 'Monitoring and assessing technology choice: the case of solar cells', *Energy Policy*, 28: 1037-1049.
- Chief Scientific Adviser's Energy Research Review Group (2002), *Report of the Group to the Performance and Innovation Unit*, Office of Science and Technology.
- Department of Trade and Industry (2001) *New and Renewable Energy: Prospects for the 21st Century - The Renewables Obligation Statutory Consultation*
- DTI (1998) 'John Battle Pushes Forward Reform of Electricity Trading Arrangements' Press Release (8<sup>th</sup> October).
- DTI (2001) *Statutory Guidance to the Gas and Electricity Markets Authority on Social and Environmental Objectives* Consultation Document (May).
- ENDS (1999) 'Ministers look towards regional renewable energy targets' *ENDS Report* (November).
- ENDS (2002), 'Small generators blast OFGEM over NETA report' *ENDS Report* Issue 325 (February).
- Grabher, G. and D. Stark (1997) 'Organising diversity: evolutionary theory, network analysis and postsocialism', *Regional Studies*, 31, 5: 533-544.
- Green D (2001) 'Small is Beautiful ? The Embedded Generators Story' Presentation at Institute of Energy Conference *NETA – the experience. Where do we go from here ?* (31<sup>st</sup> October).
- Hartnell, G. (2001) *Planning and renewables: implications for meeting the targets* CREA Conference on Regional Planning Targets (22<sup>nd</sup> March).
- House of Commons (2002) *The Renewables Obligation Order 2002* The Stationery Office.
- Hughes, T. P. (1987) 'The Evolution of Large Technological Systems' in Bijker, W.E., Hughes, T.P. and T.J. Pinch (eds) *The Social Construction of Technological Systems*, MIT Press, Cambridge.
- Johnson, A. and S. Jacobsson 'The emergence of a growth industry: a comparative analysis of the German, Dutch and Swedish wind turbine industries', in Metcalfe, S. and U. Cantner, *Transformation and Development: Schumpeterian Perspectives*, Physica/Springer, Heidelberg (forthcoming).
- Kemp, R., Schot, J. and Hoogma R. (1998) 'Regime shifts to sustainability through processes of niche formation', *Technology Analysis and Strategic Management*, 10, 2: 175-195.
- Mitchell, C. (2000) 'The England and Wales Non-fossil fuel obligation: history and lessons', *Annual Review of Energy and Environment*, 25: 286-312.
- Morthorst, P.E. (2000) 'The development of a green certificate market', *Energy Policy*, 28: 1085-1094.
- OFGEM (2001) 'Report to the DTI on the Review of the initial Impact of NETA on Smaller Generators' (31<sup>st</sup> August).
- OFGEM/DTI (2001) *Report into Network Access Issues* Embedded Generation Working Group (January).
- OXERA and ARUP (2001) *A Report to the DTI and DTLR on Regional Renewable Energy Assessments*, (6<sup>th</sup> February).
- Performance and Innovation Unit (2002) *The Energy Review*, The Cabinet Office (February).
- Steen N. (2002) 'ROCs Market Rockets' *Environmental Finance* (March 2002)
- Watson J (2002) *Renewables and CHP Deployment in the UK to 2020* Project Working Paper, Tyndall Centre for Climate Change Research.

## Leaving REFIT for the green certificate market: a jump in the dark?

Arturo Lorenzoni, Università L. Bocconi, Milano, Italy<sup>97</sup>

**Keywords:** Tradable Green Certificates, Feed in Tariff

**Abstract** Italy has opted for a support system for RES-E based on a quota from 2002. This is a new approach after the renewable energy sector has been created under a price support mechanism known as CIP6 programme in 1992-2002. The challenge for the policy makers is to combine the uncertainty of the market to the absence of risk required by the investors in this field.

Even if price based support systems, like those implemented in Germany and Spain, have given remarkable results in term of new installed capacity, the ambition of the Italian Green Certificate Market is to reconcile the growth of RES-E production with a stimulus to the efficiency of the sector.

The paper looks at the regime for new RES-E in Italy and investigates the challenges for its success.

### Introduction

Italy has started in 1999 the reform of the electricity industry for the implementation of the Directive 1996/92/EC. At the same time the vesting of the former national electricity board ENEL has been decided, with an extremely difficult task of reconciliation of conflicting goals. The maximisation of the revenue for the State from the privatisation required a strong role of ENEL, while the creation of a competitive market based on a power exchange pushed for the reduction of the market share of ENEL, which was in the region of 80% of production and 92% of distribution.

At the same time, the Directive 2001/77/EC assigns a target of 25% of electricity from RES in 2010 from a rough 18% now. Considering the contribution of some 16 GW of hydropower plants built along the past century and the increase of the demand for electricity expected in the next decade, this means some 30 TWh of additional renewable energy production at 2010. A dramatic task.

A further challenge for the industry comes from the target of the Kyoto protocol. It requires a reduction of CO<sub>2</sub> emission of 6.5% on 1990 in 2010, being at +4% in 2001. The achievement of such a target would imply the total restructuring of the industry, with the refurbishment and the conversion to combined cycles of most of the old oil fired power plant that are supplying the baseload.

As it is easily understood these tasks have goals partially conflicting and an easy solution can not be found in the short term. In addition, in the frame of such changes renewable energy sources are often perceived as a secondary issue, lacking the due attention for a long term planning.

### The reform of the Electricity Industry

The reform of the electricity industry started in 1999 is aimed at introducing competition in the generation and supply of electricity. At this end the state monopoly of ENEL was unbundled and different companies were created operating in different segments of the industry. GRTN is the independent system operator of the transmission grid, GME (Gestore del Mercato Elettrico) operates the power exchange and AU (Acquirente Unico) is in charge of the purchase of electricity on behalf of all the captive customers. They are all owned by the Government. The distribution is still mostly operated by ENEL, but it was forced to sell 15 GW of generating plant to new operators of the market. ENEL created 3 generating companies and in 2001 the Spanish company ENDESA took over the biggest Genco Elettrogen in partnership with the municipal company ASM of Brescia, while EDF and Italenergia, the major Italian independent producer, in 2002 won the tender for Eurogen. The last and smallest company Interpower should be sold by the end of 2002.

The path of the reform has been delayed by the difficulties met in the implementation of the new regime. The operation of the power exchange, scheduled for the 2001, is now expected for end 2002 and maybe later, while AU is not yet in charge of the purchase contracts for the captive market.

In addition, the operation and the ownership of the transmission grid, which have been separated in 1999, will now be merged again in a new company to be vested.

In the frame of the reform a new policy to support renewables was also designed, aimed at reconciling the growth of their penetration and competition.

The policy to support renewable energy has been based on:

- The creation of a “new renewables” portfolio, mandatory for all fossil thermal producers and
- Competitive biddings managed by the regions at the local level for new RES-E schemes.

Leaving the old system based on subsidised prices for the new quota based market implies a radical change in the attitude of the investors. The transition from one regulatory regime to another started in 1999 and is far from concluded, contributing to make uncertain the framework for newcomers and to freeze the investments. IWT, the Italian branch of Vestas, which sold 320 wind turbines in 2001, did not receive any order in the first semester of 2002, even if many prospective investors got in contact. All of them were waiting for the new market to be designed in more detail.

The risk is thus to displace investments in renewable energy again, like in the past, with an array of stop-and-go measures that made renewable energy technologies an unappealing option for big financial operators.

<sup>97</sup> arturo.lorenzoni@uni-bocconi.it

### The new challenge: reconciling RES support with competition

The support scheme implemented at the beginning of the nineties (Provvedimento CIP 6/1992, April 29<sup>th</sup> 1992) was based on a subsidised price for all the RES electricity production and for cogeneration plants. This measure was primarily intended to support the independent production in combined heat and power plants at a time when ENEL was suffering local opposition in developing new projects.

All the new power plants submitting application could get a contract to sell electricity produced to the grid at a price made up of two factors: 1) an avoided cost (investment, operation and maintenance, fuel) based on an estimate of the investment in a new gas-fired combined cycle, equal to 6.9 c€/kWh in 2000; 2) for the first 8 years of operation an extra price based on the estimated extra costs of each different technology (3.1 c€/kWh for hydro run of river over 3 MW, 5.3 for wind and geothermal, 10.2 for photovoltaic, biomass, wastes, 8.9 in peak hours for hydro with basin and run of river below 3 MW).

Both factors were linked yearly to the retail price index, except for the fuel avoided cost, which was linked to the price of a mix of fuels, so that the resulting risk of the investments was quite low.

ENEL itself could have its projects included in the support programme, buying electricity from itself at a subsidised price.

The price structure was so appealing that in 1992 ENEL proposed to create a waiting list to be updated every 6 months, in order to avoid a wild rush to connect cogeneration plants. The demands made after June 1995 were ultimately scrapped, and the programme closed in January 1997, when most of the accepted plant had not yet been built. Even many of the projects accepted will not be built, as they were simply applications made by newcomers with scarce experience in the sector. The last projects are expected to be completed in 2004, without any fine for the delay in the commissioning.

Table 1 shows over 5.6 GW of nominal new capacity promoted by the CIP6 programme. ENEL as a producer has the largest share of this new capacity.

The cost of the extra prices given to renewable power plants in their first eight years (i.e. excluding the avoided costs and extra prices paid to co-generation plants) for the whole CIP6 programme is estimated for the period 1992-2012 to be in the region of 13 billion € at year 2000 prices<sup>98</sup>. Considering also the money given to cogeneration, this is a burden for electricity consumers – 0.48 c€/kWh for domestic users in October 2001 – which implies a long-term commitment, considered that the last subsidies will be given in 2012.

The reform of the electricity industry in 1999 was an opportunity for the implementation of new support measures for renewable energy. The challenge for the legislator was to implement an effective support to

RES-E in the frame of a competitive market without creating unnecessary rents to the owners of the existing renewable power plants – mainly big hydro – which already benefited from other sources of support in the past.

Table 1: Summary of the new renewable capacity developed by the CIP 6 support programme (1992-2004)

[MW]	Third parties	Distributors	ENEL	Total capacity
Biogas	133	15		147
Biomass	266	2		268
Wind	749	-	20	769
Photovoltaic	2		3	5
Hydropower	661	141	2 127	2 929
Run of river	133	171	134	438
Wastes	56	-		56
RDF	30	-		30
MSW	408	139		547
Geothermal	-	-	443	443
Total RES	2 440	468	2 727	5 634
Cogeneration	6 188	540		6 728
TOTAL	8 628	1 008	2 727	12 362

Source: Own estimates on GRTN and Ministry of Industry data.

The Renewable Portfolio seemed to fit the Italian goal of boosting renewable electricity generation without hindering the competition in the generation phase. The portfolio has been limited to new renewable power plants, i.e. those come on line after April 1, 1999, with the aim of supporting only the construction of new renewable capacity.

From 2002 all the electricity producers or importers have an obligation to certify that at least 2% of their net sales come from new RES-E. Renewables, cogeneration (satisfying an efficiency requirement established by the energy regulator) and the first 100 GWh per year produced by each company are excluded from this obligation. This quota should grow of 0,3% per year from 2005 to 2012, raising the portfolio to 4,4% in 2012.

In order to facilitate the fulfilment of the obligation, GRTN issues a Tradable Green Certificate (TGC) for each 100 MWh produced by RES-E in the first 8 years – after up to 18 months of test operation – to plants deemed qualified by GRTN. These TGC can be traded in an exchange created on purpose by GME (Mercato dei Certificati Verdi). According to the principle of rolling redemption, after 8 years, the renewable plant can no longer obtain TGCs and has to compete on the electricity market. TGCs can be sold separately from electricity and GRTN has an obligation to purchase electricity from renewables and cogeneration, giving them privileged access to the grid.

The mechanism of rolling redemption has an implicit strength in promoting the construction of new power plants, as after 8 years the capacity required to satisfy the portfolio in the first year has to be replaced. In this way, not only the growth of demand implies a growth of RES-E generation, but also the replacement of qualified plants after 8 years. Nevertheless, the trend of growth due to the mechanism is not sufficient to raise

<sup>98</sup> This figure was estimated by multiplying the year 2000 extra prices by the energy produced in 8 years by all the RES-E projects admitted to the programme

the contribution of RES-E as required by the EU Directive on renewable energy. A quota of 4.5% should be introduced in order to reach the minimum goal of +25 TWh before 2012. With a lower quota the growth of RES-E will not keep the pace of the electricity demand and the penetration of RES-E will decrease.

Table 2 RES-E penetration (new and existing) in the Italian electricity sector in our forecast

year	RES-E estimated share of electricity production
2001	19.3%
2002	18.8%
2003	18.4%
2004	17.9%
2005	17.7%
2006	17.5%
2007	17.3%
2008	17.1%
2009	17.8%
2010	17.7%

Defaulting producers will have to pay a fine equal to 1.5 times the maximum price of TGC on the GME market in the previous year, that will be devolved to a fund aimed at supporting renewables. This measure is part of a new proposal of law presented in 2002, which is essential in making the new market take off.

A critical aspect is the access of refurbished plants to the market: the requirements have been specified in March 2002 for hydro and geothermal power stations. They will have the right to receive TGCs in function of the investments made on the plant: 100% of the production when a certain amount per installed kWh will be invested, scaled down to zero with lower investments.

A further challenge was managing the transition from the old support system, committing the electricity consumers until 2012, to the new one based on competition. A large part of the CIP6 contracts are in fact eligible for the Green Certificates, as they came on line after March 1999. These projects have two choices:

1. They can give up the CIP 6 contract and opt for the TGC. This option is reputed to be quite uncertain because the TGC price is unknown;
2. They can keep the CIP6 contract, but their TGCs will be traded by GRTN, who pays them the extra price. GRTN sells the TGC on the market at a price set by law as the average of the extra prices paid to acquire electricity from RES plants in the CIP6 programme that year. GRTN can recover at least part of its extra costs or even all of them, in case it could sell all its TGCs.

Most of the producers are expected to opt for the CIP6 contract, as it assures an interesting cash flow for 8 years, instead of betting on the TGC market.

In addition, GRTN can also sell TGC non related to a RES production in case it expects to be short, with the obligation to cover them in three years. This option seems to be of scarce interest for GRTN, which would play a dangerous role in exposing itself to trading without any influence on the supply of TGCs.

Figure 3 shows the expected supply of TGCs in the coming decade from projects under CIP6 contract, both of distributors (mainly ENEL) and third parties, and qualified as IAFR (renewable energy fed power plants) by GRTN. It is also shown the forecast of the demand of TGCs.

It is evident that GRTN will strongly influence the market in the first years of its operation, as it will sell most of the certificates at a regulated price. Figure 3, in fact, shows that the plants under CIP6 contract could satisfy the demand of TGCs, but with fixed prices. The market will easily accept the TGCs of new producers if they will ask a price lower than that imposed to GRTN certificates, that will become a ceiling.

The capability of GRTN to sell TGCs not related to any RES production could hide the scarcity on the market and depress the price signal for new prospective investors.

Considering the large production of CIP6 projects admitted to receive TGCs, GRTN, conscious that it could strongly influence the future market, is likely to not resort to virtual emissions.

### The expected price of TGCs

While GRTN has a lot of technical duties, its daughter company GME has to operate a market where Green Certificates can be freely traded. The price of TGCs should be set by the equilibrium of supply and demand. Nevertheless, the offer of GRTN of a great amount of certificates at a fixed price will be the reference for investors for the next 5 years.

We made a simulation based on the expected production of RES-E power plants under CIP6 contract and on CIP6 prices for the year 2000 (could be updated at 2003 according to the variation of the retail price index). We found a reference price for these TGCs as shown in Figure 1, that will be an yearly updated ceiling.

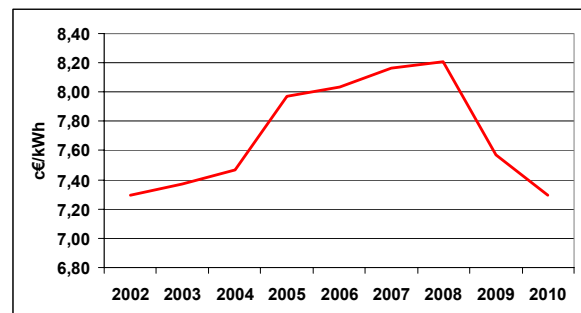


Fig. 1: Forecast of the price of the TGC sold by the grid operator GRTN

TGCs can also be traded privately out of the official trading floor of the GME. This creates some problems of control of the validity of the certificates (the details about the registration of each sale of a TGC have not yet been issued). At the same time there is the opportunity for the renewable producers to stipulate long-term contracts (up to 8 years) for selling certificates at a price maybe lower, but secure.



## The demand of TGCs

The renewable portfolio is set on the electricity produced and imported. The choice to charge the producers with the obligation is due to the reduced cost of control.

A forecast has been made of the demand of TGCs in the coming years. We assumed a reasonable growth rate for the demand of electricity and combined heat and power production, with an increase of RES-E production minimum to satisfy the obligation, which grows, from a flat 2% in 2002-2004, at an annual rate of increase of 0.3% until 2012. According to our estimate the demand of TGCs should be in the region of 3.5-9 TWh in the next decade.

Table 3: Estimate of the future demand of electricity and RES-E portfolio (TWh per year)

Year	Final Electricity Demand	RES-E	CHP	Quota
2002	322.718	58.548	54.771	3.368
2003	331.108	58.712	56.771	3.532
2004	339.883	58.885	58.771	3.705
2005	348.550	59.578	62.771	4.398
2006	357.089	60.302	66.771	5.122
2007	365.659	61.541	71.771	6.361
2008	374.252	62.290	76.771	7.110
2009	383.047	66.198	80.771	7.808
2010	392.049	67.251	82.771	8.703

At February 2002, the IAFR-qualified, extra-CIP6 plants were 154 with a total capacity of 1385 MW and an expected production of 2,63 TWh per year. The share of each technology is reported in Figure 2.

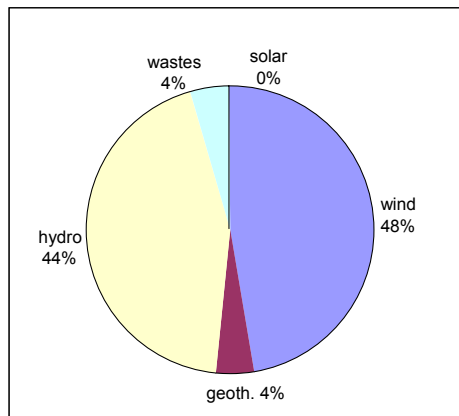


Fig. 2. The new plants qualified for the TGC market in February 2002

The production of CIP6 plants with TGC is expected to decrease to zero in 2013, when all the subsidised production of these schemes will be terminated.

The uncertain feasibility of part of these CIP6 projects, mainly in the field of biomass, suggested that a reduced estimate should also be made, considering the mortality rate of CIP6 projects in the 1999-2001 time-frame (IPP min in Figure 3).

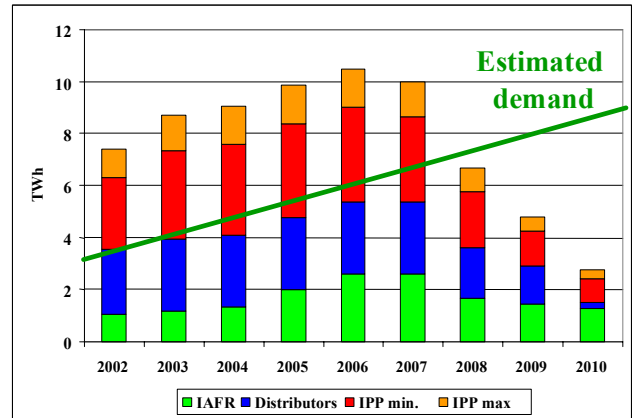


Fig. 3 Estimate of the future trend of the Green Certificate market

## The future still looks dark

Even if the market has formally become operational in 2002, it is hard to evaluate the capability of the new instrument in promoting new renewable energy production. Almost 80% of the plants qualified as IAFR for the TGC market are at the project phase and not yet fully built. They are on the good track to take advantage of the certificates, but at least part of them still wait to see how the market will evolve.

Other projects are at the design stage and could be exploited soon, but the investors are waiting for a better assessment of the market, being difficult at the moment to finance any new project.

The first step in the right direction was setting a fine for the defaulting producers. The penalty equal to 1.5 times the maximum price in the previous year is a fair measure, but it is not yet law, being part of an overall reform law for the energy industry, which is expected to become effective before the end of the year 2002.

Other aspects still remain critical:

- Size of the certificate**  
 The choice to set at 100 MWh the size of a TGC could displace some small producers. In fact, even if they can aggregate their productions to reach 100 MWh, for some technologies (PV) the cost for the aggregation of different producers could be high. Why not a smaller size?
- Energy sources admitted**  
 The Italian energy policy advocated the inclusion of wastes and big hydro among the renewable technologies. Different choices could be made by other countries. Could this be an obstacle to the integration of the TGC market at the EU level?
- Lack of a long term target**  
 The TGC market is not backed by specific documents of energy policy setting binding long-term targets, as required by the EU Directive 2001/77/EC. A clear commitment to maintain support to RES-E in the long term is not taken, and investors perceive this as a risk. A focused policy act with targets for RES-E at the national level, as required by the renewable energy Directive, would boost the confidence of new investors in the new market.

- *Administrative costs*

A basic requirement for a support scheme is its low administrative cost. It is not yet known who has to pay the costs of the TGC market and how. Is this a system cost to be socialised? Or should the suppliers pay a fee to participate? Or perhaps the consumers should pay a surcharge to their electricity bills?

- *Reciprocity*

It is provided that the obligation can also be fulfilled by importing electricity from power stations fed by renewable sources commissioned after 31 March 1999, but only from countries adopting similar support systems for renewable energy, open to the power stations located in Italy. At this time such countries do not exist. Moreover, in the case of import, there is the additional barrier that the TGC is traded jointly with its electricity production and not separately as it happens for the Italian renewable production. Could these conditions ever be met?

- *Stability of the programme*

A closing date of the programme has not been set and it could in theory be interrupted soon. It would be important to guarantee the investors that the TGC market will remain operational for a reasonable time.

Under these conditions it appears difficult to finance new initiatives aimed at fulfilling the goals of the directive 2001/77/EC, even if the lower estimate of 75 TWh of RES-E is chosen (20 TWh to be added).

In addition, it appears urgent to co-ordinate the support to RES to the other instruments of environmental policy under development in the EU. CO<sub>2</sub> abatement is only one of the benefits of renewables: how can these other benefits be taken into account properly? When the motivation for supporting renewable energy is found only in their potential for reducing greenhouse gas emissions, RES could be disadvantaged respect to other measures which appears cheaper, like Joint Implementation or Clean Development Mechanisms. The challenge for the renewable energy industry is to highlight the additional benefits of renewables on other measures.

### **Other non technical barriers**

The growth of RES in Italy towards the goals set by the Directive 2001/77/EC seems to be quite difficult also for other reasons, not directly linked to the support scheme or the physical availability of the resources.

The construction of new plants is highly discouraged also by the length of the procedure for authorisations, and the wide range of rules set at the local level (Regions or even municipalities) that do not allow to repeat successful projects. An effective action in favour of RES would have to start from these basics, otherwise a new class of small investors will hardly arise and the existing players of the electricity market will be favoured in big scale projects that can not exploit the full dividend of renewables.

### **Conclusions**

The TGCs market is a great opportunity to develop new RES in Italy, but some steps are still missing for the instrument to be fully operational. The indeterminate aspects and the uncertainty of the long term regulation are delaying the new investments and pose some questions on the effectiveness of the market approach.

The targets accepted by the Italian Government at the international level for 2010 will not be achieved with the TGC alone and other measures should be enforced. With all the technologies in competition, the only possibility for exploiting the resources relatively more expensive – namely biomass and wastes – is to set a feed in tariff specific for these sources, otherwise they will be permanently out the TGC market. An investor will have the possibility to choose between the feed in tariff and the issue of certificates.

A dramatic effort has to be done in Italy to attract new investments in the field of renewable energy and achieve the international commitments. It is necessary to reduce the risk for the new investors, aware that in any case the TGC market recently started will make only part of the work. Without a firm commitment at the national as well as local level, Italy will be in default with its goals in 2010.

### **References**

- Decreto legislativo 16 marzo 1999 N.79, 'Attuazione della direttiva 96/92/CE recante norme comuni per il mercato dell'energia elettrica' Gazzetta Ufficiale 31/3/1999, Serie generale n.75
- Decreto legislativo 11 Novembre 1999, 'Direttive per l'attuazione delle norme in materia di energia elettrica da fonti rinnovabili di cui ai commi 1,2 e 3 dell'articolo 11 del decreto legislativo 16 marzo 1999, n. 79', Gazzetta Ufficiale 14/12/1999 n. 292
- De Paoli L Lorenzoni A (1999) *Economia e politica delle fonti rinnovabili e della cogenerazione* Franco Angeli, Milano.
- EC (1997) 'Commission's White Paper for a Community Strategy and Action Plan' COM (97) 599, 26/11/97, [http://www.agores.org/POLICY/COM\\_STRATEGY/WHITE\\_PAPER/default.htm](http://www.agores.org/POLICY/COM_STRATEGY/WHITE_PAPER/default.htm)
- EC (2001) Directive 2001/77/CE of 27 September 2001, on Official Journal L283 of October 27, 2001
- Espey, S (2001) 'Renewables portfolio standard: a means for trade with electricity from renewable energy sources?' *Energy Policy*, **29** 557-566
- GRTN (2000) 'Procedura di qualificazione degli impianti alimentati da fonti rinnovabili' november in <http://www.grtn.it>.
- GRTN (2000) 'Dati statistici sull'energia elettrica in Italia 1999' Roma
- Morthorst P E (2000) 'The development of a green certificate market' *Energy Policy* **28** 1085-1094.

## Session 3: Promoting RES: stakeholders point-of-view

### The effect of renewable energy supporting strategies on society. The issue of public acceptance

Andreas Wagner, EWEA, German<sup>99</sup>

**Keywords.** Renewable energy, Wind energy, Support policies, Public acceptance.

**Abstract.** The paper is focused on the effects of support policies for renewable energy technologies (RETs) on society. In the last decade different promotion schemes have been implemented in European countries to increase the development of renewable energy sources. It is obvious that different cultural traditions within European countries call for their own well adapted solutions. Nevertheless, clear trends can be seen. Especially the birth and high-rise of wind energy in some countries is an important indicator for the success of the support measures applied. In general, feed-in tariffs have proven their ability to boost the development of RETs.

#### Introduction

The *European Wind Energy Association (EWEA)* was founded in 1982 with a set of goals to be achieved:

- To create a sustainable future by maximising the use of wind energy;
- To create awareness of the potential of wind energy towards this end;
- To represent the interests of the wind energy sector.

Today, the association has over 20,000 members. A lot of them represent the industry – manufacturers, utilities, developers, R&D institutes, universities, financiers etc. – but also national wind energy associations and individuals are on board.

#### Capacity building

*The market – building up a critical mass*

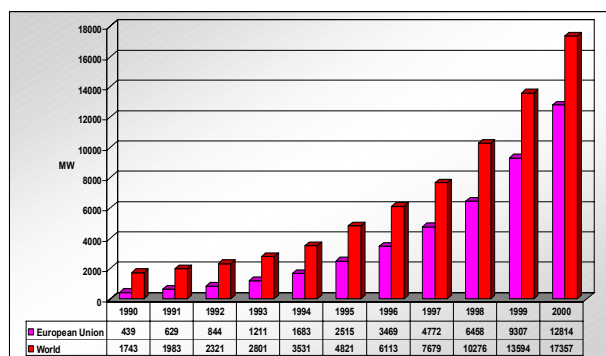


Fig. 1 Cumulative wind energy – installed capacity

In general, *renewable energy technologies (RETs)* are associated with a lot of benefits and their exploitation is of crucial importance to achieve the smooth transition to a cleaner and more sustainable development in the energy sector. As a first step towards this

target, in the last decade, especially within Europe the birth and boost of wind energy has begun, see Fig. 1.

Among the Top-10 Markets for wind energy worldwide Germany took the leading position in the last years, followed by the U.S.A., Spain and Denmark. As there can be seen from Fig. 2, seven of the ten leading markets with respect to wind energy are Member States of the European Union.

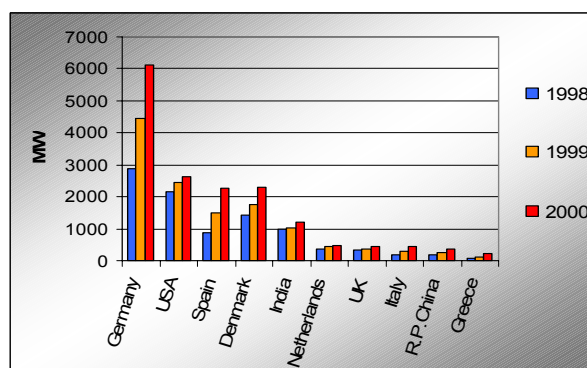


Fig. 2 Top-10 Markets in the World, EWEA 2002, based on: BTM Consult ApS, 2001

#### The owners and operators

A look at the owners and operators of wind power plants in the leading countries is undertaken in Table 1, which reflects the country-specific situations and the different cultural traditions, respectively.

Table 1: Comparison of owners and operators of wind power plants with respect to their investment size for Germany, Denmark, United Kingdom and the US

Size of investment	< 1M€	1-5 M€	5-10 M€	> 10 M€
Individual private investor (e.g. farmers)	D, DK	D		
Group of private investors (e.g. co-ops)	D, DK, UK	D, UK	D, UK	D
Small companies < 15 M€	UK	UK	D, UK	D
Larger companies > 15 M€		UK, D	UK, D, E, US	UK, D, E, US
Utility projects		UK, D	UK, D, US	UK, US

In Denmark – the first country within Europe which took the leading position with respect to wind power in the late eighties and early nineties – the market is dominated by private investors, both individuals and groups of investors. Of course, their typical size of investment is rather small (< 1M€). This reflects the state of the art technology at the time, as well as the typical cultural tradition, as in general within Denmark local communities have a strong role.

<sup>99</sup> andreas.wagner@ps.ge.com

A totally different situation shows the US market: It is dominated by large companies and larger utility projects with a huge specific investment size, even in the 1980s (5–10 M€ and more).

For Germany, a country with a de-centralised and fragmented political system, and the UK with its centralised political system, where regional autonomy is growing recently, the market seems to be more homogenous: Nearly all kind of investors are represented, even though there are some important distinctions to be made. Utility based investments are more common in the UK. In Germany, private investors have been dominating the market with about 95 percent market share. Both has to do with the support mechanism in place which has given more stability for private investments in Germany, compared to the rather risky tendering procedures applied in the UK throughout the 1990s. Public acceptance issues have to be seen linked to the kind of political framework in place. Of course, for private investors budget restrictions occur to some extent, as projects become bigger, with tens or even hundreds of million Euro investment (e.g. offshore).

#### Policy makers

The influence of policy makers on the development of RETs is of crucial importance. In this context, the following areas of activity have to be mentioned:

- Clear political commitment, or even a consensus on supporting schemes for RETs;
- Create favourable legal framework that allows citizen participation;
- Local/regional wind energy plans;
- Information dissemination.

#### Factors influencing public acceptance

Aside from political will, public acceptance determines the success of *renewable energies (REs)* in a certain country. A set of factors influencing public acceptance can be named:

- Openness of Support Systems for public participation;
- Political systems/cultures and mentality (e.g. centralized or decentralized system, etc.);
- Local/regional tax revenues/ job creation by RE;
- Environmental awareness of decision-makers, and the general public;
- Social acceptance through information policy, marketing, alliance building among associations;
- Share of RE in the electricity system (wind), in relation to population density and size of the country.

#### RE Support Policies

##### *Lessons from the past – Feed-in Tariff vs. Tendering Quota Systems*

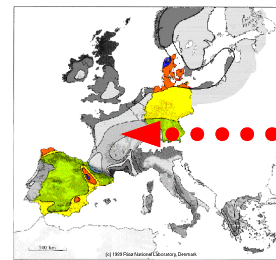
Feed-in Tariff and Tendering Quota Systems have been the most popular policy instruments to support RETs within Europe in the past decade. With respect to their

effectiveness on fostering the development of RETs it must be stated: Feed-in Tariffs are clearly preferable policy tool for a rapid market introduction policy. As there can be seen from Table 2 and Fig. 3, in countries with Feed-in Tariff schemes the installed capacity of wind power plants has reached a level of about 10.6 GW at the end of 2000, although the wind potential is quite moderate. On contrary, in countries with high wind potential where Tendering Quota Systems have been applied, only 0.5 GW of wind power have been installed in the same time. This picture hasn't changed substantially in 2001.

Table 2: Development of wind energy in countries with Feed-in Tariff and Tendering Quota Systems

	Country	Installed capacity (1999)	New installation (1999)	European market share (1999)	Installed capacity (2000)	New installation (2000)	European market share (2000)
		MW	MW	%	MW	MW	%
Premium price markets	Germany	4,442	1,567	47.7	6,113	1,671	47.7
	Denmark	1,738	290	18.6	2,300	562	17.9
	Spain	1,495	661	16.0	2,270	775	17.7
	Total	7,675	2,518	82.5	10,683	3,008	83.4
Tendering fixed quota system markets	UK	362	29	3.9	406	44	3.2
	Ireland	74	1	0.8	118	44	0.9
	France	25	6	0.2	66	41	0.5
	Total	461	36	5.0	590	129	4.6

#### REFITs (RE Feed in Tariffs)



#### Total installed capacity

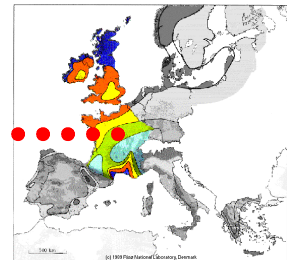
by 2000

**10,683 MW**

Growth in 2000

**3,008 MW**

#### Tendering → RECs



**590 MW**

**129 MW**

**NB: France introduced REFITs for wind power on 8 June 2001**

Fig. 3 Comparison of the wind potential and the development of wind energy in countries with Feed-in Tariff and Tendering Quota Systems

#### Objectives of RE Support Policies

In general, with respect to RE Support Policies the following objectives are named:

- Environmental and climate policy objectives;
- Capacity increase;
- Cost reduction;
- Openness and flexibility to attract new investors;
- Foster regional development by offering investment opportunities;
- Job creation and industrial development.

#### Case study wind energy – Employment effects

The fast growing wind energy industry in the European Union is an impressive example for possible employ-



ment effects of an accelerated development of RETs. Of course, such an expansion was the result of the encouraged Support Policy within some EU countries.

In more detail, within the wind energy sector major areas of job creation are:

- Component Manufacturing (local, regional, national),
- Machinery Assembly (regional, national, international).
- Construction and Grid Connection Operations (local, regional),
- Wind Farm Operation & Service/Maintenance (local, regional),
- Project Development (local, regional, national),
- Research and Development (national),
- Approval and Certification (national).

To illustrate the above mentioned points, the total job creation in the wind energy sector (direct/indirect) amounts to approximately 70,000 jobs across the EU, or 35,000 in Germany, respectively. It's important to mention the fact that these jobs have mainly been created within only 10 years.

### Conclusions

The most important conclusions of this analysis are:

- Careful design and consistency, and long-term stability of RE Support Policies is required;
- The local, regional and national benefits of RE must be identified and pro-actively communicated by the wind industry and politicians alike;
- For the development of policies it is important to take into account historical development and political structures, incl. electricity market;
- Investment opportunities and financial incentives for individuals (e.g. tax system, co-operatives etc.) are of high relevance to increase the public acceptance of RE;

Further comparative analysis and research studies are definitely needed to better understand the underlying success factors to public acceptance issues.

## The experience of Spanish renewable energy developers and investors

*Manuel Bustos, Spanish Renewable Energy Association- APPA, Barcelona - Spain<sup>100</sup>*

**Keywords.** Renewable energy, RES premiums, RES barriers, REFIT, Spain.

**Abstract.** The paper is focused on the framework conditions that have made possible the birth and development of the renewable sector in Spain. Dozens of new companies have emerged in the wake of a stable legal framework that has politically guaranteed environmental premiums for electricity produced from renewable energy sources (RES-E). This feed-in framework has delivered good results in some technologies – mainly in small hydro and wind energy – although has not given enough profitability to foster biomass, biogas and solar. Nevertheless, APPA regards the Spanish support scheme as a good example of how to combine market forces and incentives for *clean* energies at an affordable cost and without complex mechanisms or bureaucracy. Therefore, investors and independent developers are reluctant to be involved in the experiments already done in some other countries with alternative schemes such as the tradable green certificates. In order to reach the 12% goal enshrined in the *Electricity Act 54/1997* and in the *National RES Development Plan 2000-2010* the small hydro and wind premiums will have to be kept though increasing the compensations for biomass electricity. Administrative and grid barriers should also be removed to foster RES development. The achievement of the 12% goal will impossible unless current energy consumption trends are no curbed.

### A stable legal framework

The *Spanish Renewable Energy Association – APPA* was founded in 1987 with only a few small hydro developers. Fifteen years later the same organisation brings together more than 200 corporate members, mainly independent producers from small hydro, wind, biomass and solar, whose total capacity is more than 2,500 MW, only in Spain. This evolution illustrates the progress of renewable energy in the country.

This development would not have taken place unless the promotion of renewable energy sources of electricity (RES-E) had not been a national policy in Spain for 20 years. Since 1980 and under different Governments and different political majorities, there has been a continuity in the legal framework aimed at fostering RES-E.

The three Acts that have regulated the energy and/or electricity sectors in Spain since 1980 – the *Energy Conservation Act 82/1980*, the *National Electricity System Act 40/1994* and the *Electricity Act 54/1997* (currently in force) – have given support to the development of RES-E. Whereas the main goal of such a policy in 1980 was to reduce energy dependence, both the 1994 and the 1997 Acts put more emphasis on the environmental benefits of RES. Regardless of the

<sup>100</sup> The author works as International Affairs Officer at APPA's headquarters (Paris, 205 ·08008 Barcelona, Spain · [mbustos@appa.es](mailto:mbustos@appa.es) ·Tel. +34 93 4142277).

grounds for this, these different Acts have set a stable legal framework for 20 years.

#### *Electricity Act 54/1997*

The *Electricity Act 54/1997* gave up the old notion of electricity supply as a public service and opened the door to a new electricity legal framework aimed at making the guarantee of supply to all consumers compatible with the principles of objectivity and transparency within a liberalised market. This Act brought into force in Spain the provisions of the European Directive 96/92/EC.

Such an Act enshrined two different electricity production systems: the *Ordinary System* and the *Special System*. Whereas in the former the regulatory basis is the free generation market or electricity pool where demand and supply bids for electricity are matched and prices are set in consequence, in the latter all generation plants below 50 MW belonging to three clearly separated areas – cogeneration, RES-E and waste – are given a special treatment justified by their contribution to “the environmental protection, energy efficiency improvement and the reduction in consumption”.

According to article 30 of that Act RES-E producers are entitled to incorporate all their output power into the grid system and to receive as remuneration the general generation hourly pool price plus a premium or incentive fixed by the Central Government for all Spain. The total amount paid to RES-E generators must be between 80% and 90% of the average electricity price estimated each year by the Government. That average is calculated by dividing the total electricity supply revenues estimated from the whole electricity supply billing (excluding VAT and other taxes) by the total estimated power supplied<sup>101</sup>.

Regarding hydro this rule only applies to small plants (10 MW or below). The Act allows solar plants to surpass such a range. The authorisation of any of these special plants is left in the hands of the *Regional Autonomous Governments* (Article 28), according to the federal political system in place in Spain since 1978.

As far as RES-E are concerned the *Electricity Act* contains a very important clause in its 16th Transitory Provision, since it not only enshrines the European 12% goal as a legal one but also links the existence and amount of RES premiums to the fulfilment of such a goal. This Provision states that “In order for RES to satisfy at least 12% of Spain’s total energy demand by the year 2010, a plan shall be drawn up to promote renewable energies and *whose objectives shall be taken into account in the setting of premiums*”. This Provision linking the premiums with the achievement of ambitious goals has been a key one in order to strengthen the confidence of developers and financial investors in the long-term stability of the Spanish RES policy. Thus, premiums have been regarded by everybody as politically and legally guaranteed.

<sup>101</sup> The Spanish Central Government estimated that electricity revenues for the year 2002 will total 13,457 M€ with a total supplied power of 197,425 kWh and an average electricity price of 6.82 €/kWh.

#### *Royal Decree 2818/1998*

This *Special System* was developed in depth by the *Royal Decree 2818/1998*, which entered into force on January 1st 1999. This legal disposition begins stating in its preamble that “the established incentive for RES facilities has no time limit placed on it because their environmental benefits must be internalised and RES special characteristics – higher costs – prevent them from competing in a free market”.

Regarding the economic arrangements this *Royal Decree 2818* fixed the amounts for the 1999 RES-E premiums or incentives established. As foreseen in the 18th article of said Decree the premiums have been adjusted annually since then by the central Government “in line with the variation in the average electricity sale price<sup>102</sup>, that shall be applied to sum total of the market price plus the premium”. Table 1 shows the evolution of premiums since 1999.

Table 1: Evolution of RES-E premiums by technology

<b>RES-E PREMIUMS (Euro cents)</b>				
	1999	2000	2001	2002
<b>Wind</b>	3.16	2.87	2.87	2.89
<b>Smallhydro</b>	3.27	2.98	2.98	3
<b>Biomass</b>	3.04	2.76	2.76	2.78
<b>Biogas</b>	2.82	2.55	2.55	2.57
<b>Solar &lt;5 kW</b>	36	36	36	36
<b>Solar &gt;5 kW</b>	18	18	18	18

APPA

4

Although the premiums are paid directly by the distributors who are fed with the electricity from the renewable generator, they are entitled to pass such amounts to the National Energy Commission (CNE), which they always do. Premiums are legally regarded as a permanent cost of the electricity system like nuclear fuel costs or stranded costs. Premiums are therefore paid by all consumers as any other permanent cost of the system.<sup>103</sup>

In order to offer RES-E producers a way to know fully in advance their kWh revenues regardless of hourly market price changes, the same *Royal Decree 2818* has given producers the right to opt for a *fixed price* instead of the “market price + premium” basic option. That *fixed price* is also adjusted annually by the Government according to the variation in the average electricity sale price. Table 2 compares both options in 2002 assuming an average market price of 3.6 €/kWh. Notice that the basic option will be a bit better in terms

<sup>102</sup> The average electricity sale price is defined as the forecast income from billing for electricity supply divided by the forecast electricity supplied. See footnote 1 for year 2002 estimate.

<sup>103</sup> Although all independent RES-E generators have chosen this feed-in scheme, according to the Spanish legislation they could follow two other alternative schemes: to make offers directly to the electricity market or to sign physical bilateral contracts with distributors, suppliers and qualified consumers. In both cases they are also entitled to receive the same premiums as in the feed in scheme.



of revenues, as actually happened last year, although the difference between the two options is rather small. Most RES-E producers follow the basic “market + premium” option. Legally, they are only entitled to change from one option to the other once every year.

Table 2: Comparison between premiums and fixed prices

<b>RES PRICES 2002 (Euro cents)</b>		
	<b>Fixed Prices</b>	<b>Market Price + Premium</b>
<b>Wind</b>	6.2	3.6+2.8
<b>Smallhydro</b>	6.3	3.6+3
<b>Biomass</b>	6.1	3.6+2.7
<b>Biogas</b>	5.9	3.6+2.5
<b>Solar &lt;5 kW</b>	39	3.6+36
<b>Solar &gt;5 kW</b>	21	3.6+18

APPA

3

According to the 32nd article of this Royal Decree “every four years the premiums set in this Royal Decree shall be revised by taking into account the evolution of the price of electric power, the participation of these facilities in the coverage of demand and their impact on the technical management of the system”. Hence, later this year the Central Government will have to carry out the first revision of such premiums. It is expected that the Government will keep the current amounts of premiums though biomass and biogas ones should be increased to ensure the required profitability of plants and investments.

The existence of both the “market price + premium” scheme and the annual adjustment of premiums and fixed prices according to the variations in the average electricity sale price stress the market oriented approach of the Spanish support system. This way all reductions in costs brought about by conventional producers in the electricity market are passed onto RES-E producers’ revenues. Thus, APPA regards the Spanish support scheme as a good example of how to combine market forces and incentives for clean energies without complex mechanisms or bureaucracy. Moreover, this framework is able to deliver quite good results at an affordable cost: RES-E generators within the Special Regime received last year premiums under this scheme that totalled 335 M€, which represents only 2.4% of the total electricity supply revenues.

### RES framework: goals and achievements

The Spanish support system has been able to deliver goods results in some technologies but obviously it has not been capable of overcoming alone all kinds of barriers.

As was foreseen in the 16th Transitory Provision of the *Electricity Act*, the Central Government adopted in 1999 a *National RES Development Plan 2000-2010* whose general and specific goals are shown in Table 3 and 4.

Table 3: Spanish RES Plan: general goals by 2010

<b>SPANISH RES DEVELOPMENT PLAN 2000-2010</b>		
	<b>2000</b>	<b>Goals 2010</b>
<b>Gross Electricity Gener. (GWh)</b>	<b>224,875</b>	<b>260,063</b>
<b>RES-E (GWh)</b>	<b>37,974</b>	<b>76,458</b>
<b>RES-E (%)</b>	<b>16.9%</b>	<b>29.4%*</b>
<b>RES-E (-Hydro&gt;10 MW)(GWh)</b>	<b>11,059</b>	<b>45,511</b>
<b>RES-E (-Hydro&gt;10 MW)(%)</b>	<b>4.9%</b>	<b>17.5%</b>

APPA

\* Same 2010 goal as European Directive RES-E <sup>4</sup>

Table 4: Spanish RES Plan: goals and achievements by technology

<b>RES PLAN 2000-2010 EVOLUTION</b>		
	<b>2010 Goal</b>	<b>2001</b>
<b>Wind</b>	<b>9000 MW</b>	<b>3337 MW</b>
<b>Smallhydro</b>	<b>2230 MW</b>	<b>1607 MW</b>
<b>Biomass</b>	<b>1896 MW</b>	<b>164 MW</b>
<b>Biogas</b>	<b>150 MW</b>	<b>45 MW</b>
<b>Solar PV</b>	<b>143 MW</b>	<b>16 MW</b>

APPA

5

Actually, wind is the only RES technology on the right track to achieve the 2010 goals. The stable legal framework, the right level of the wind premiums and the regional development plans put in place by many Autonomous Regional Communities have been able to foster a swift wind development with more than 800 new MW installed last year.

As far as the small hydro sector is concerned, only 87 new MW were added to the installed power in Spain over the last two years. As the Spanish Renewable Energy Agency (IDAE) states in its last regular report “the pace at which new small hydro plants are currently being installed is insufficient to achieve the 2010 goals”. This situation clearly points out that a good support system in terms of economic revenues is not enough to overcome the administrative and environmental barriers that prevent small hydro from developing all its potential.

Other technologies such as biomass and solar have been hindered from really taking off by too low premiums, among other barriers. That’s why APPA has asked the Government to increase biomass and biogas premiums in order to foster new investments, guarantee their profitability and deliver the planned power within the National RES Development Plan 2000-2010. Biomass development would also require a more integrated approach capable of taking into account environmental and agricultural considerations.

### *Main barriers for RES-E development*

The achievement of the 2010 goals will be impossible if the current trends in energy and electricity consumption – 50% increase in the last decade – are not curbed. More concrete barriers for RES-E development have to do with the weak grid infrastructure in some parts of the country – a problem that is being solved partly by agreements to share the cost of grid strengthening between groups of wind developers – and the connection with the distributors' grid. Independent developers usually face substantial difficulties in reaching an agreement with the grid operators, commonly big utilities, which in many cases have been abusing their dominant position to try to avoid or delay access to their networks by independent RES-E operators. The present legal regime regarding grid connection is completely outdated –it was passed in 1985– and unsuitable for RES-E plants. A new legal framework is in the pipeline in order to guarantee a more transparent and objective procedure.

Thirdly, it seems essential to streamline administrative procedures regarding authorisation, since at present bureaucracy makes often this process to be a nightmare. There should be also some kind of harmonisation among Autonomous Regional Communities since each of them follows currently its own singular procedure.

Moreover, RES-E development has been only possible in those Spanish regions where a wide political and social consensus has been achieved between the Autonomous Government and the local councils. Last but not least, social and economic local agreements have helped to prevent conflicts with local organisations and residents. Information campaigns and careful environmental impact assessments have helped in many cases to overcome landscape concerns of local population and lack of energy awareness.

### **Conclusion: Spanish Developers' Perspectives**

The current Spanish support system has demonstrated its efficiency in delivering good results in those RES-E technologies with the appropriate amount of premium. Financial institutions have confidence in the stability of this framework and its ability to combine market forces and incentives for *clean* energies without complex mechanisms or bureaucracy. The framework needs only to be improved to deliver better results and be complemented by new policies aimed at removing pending administrative and market barriers. For the time being, Spanish independent investors and developers are pleased with the feed in economic scheme and are therefore reluctant to be involved in the experiments already in place in some other countries with alternative schemes such as the *tradable green certificates* or voluntary approaches such as *green electricity offers*.

## Session 4: Promoting RES in accession countries

### How to justify and define a feed-in tariff? A debate and decisions in Slovenia, 2002

*Mihael G. Tomšič, Jožef Stefan-Institute, Slovenia*

**Keywords.** Feed-in tariffs, electricity from renewable energy sources and CHP, internalisation of externalities, regulatory dynamics, Slovenia.

**Abstract.** Electricity produced from renewable sources supported by feed-in tariffs may become an economic burden on the national economy and may interfere with electricity markets. Setting of the feed-in tariffs, their level and structure should be consistent with the economic, environmental and other strategic goals. Also, the authority is in a dynamic regulatory situation. A value-based approach to tariff setting is described and regulatory dynamic considerations discussed. Feed-in tariffs, as further modified by policy and investor needs considerations and adopted in Slovenia in March 2002 are presented.

#### Introduction

##### *Legal basis and choice of the RES support instrument*

The Energy Act (EA) of 1999 of Slovenia has been promulgated primarily as a transposition of the EU energy market directives into national law, as part of the accession process. In the policy declarations of the Energy Act, renewable energy sources (RES) and "conversion with very high efficiency" (virtually equivalent to combined heat and power production, CHP), jointly defined as "qualified production of electricity" (QP) are to be provided special support.

As to the type of support, EA provides legal basis for either a green certificate system (a quota system, Art. 19) or a feed-in tariff (as "priority dispatch", Art.24.). Further options, such as investment subsidies from the budget, are possible without specific legal framework.

A recent overview (Haas, 2001) reports that a prevailing majority of EU countries apply a feed-in tariff, set by a regulatory authority, for support of electricity production from RES, either uniquely or in combination with other instruments. In a policy support study performed in the year 2000 the options for promotion of qualified production were reviewed (IJS, 2000) from the point of view of their applicability in Slovenia. Foreign as well as domestic experience to date provided sufficient basis for a decision to proceed first with the feed-in tariffs. This decision is the basis for the work reported here.

##### *Feed-in tariffs and energy markets*

Better economic efficiency of the energy sector is sought by opening of the markets for electricity and gas, in addition to the already developed markets for non-network energies. Any support mechanisms for particular types of energy sources may distort the markets. Precautions are taken by the regulators, such

as the provision of the electricity directive of the EU, where only up to 15% of domestic primary energy sources for electricity production may receive a preferential treatment ("priority dispatch").

Often existing market conditions are distorted so as to discriminate against renewable and other decentralised power production, at the least by:

- lack of internalisation of external costs of large-scale and fossil-based electricity production,
- market rules disfavouring distributed generation, and
- market power of incumbent large-scale producers.

Support of renewable electricity production by feed-in tariffs may be viewed as violation of the single market for electricity as a commodity. On the other hand, imperfections and single-mindedness of the market mechanism, which focuses on the commodity price only, requires corrections. One way is to create parallel markets, such as the hedging (derivatives) market, or a market for "green certificates", a token of the desired renewable qualities of production. Reliance on feed-in tariffs lacks the sophistication of multi-commodity situation, and may be more likened to the historic situation when a multi-faceted social contract existed between the community and a (monopolistic) electricity producer.

Feed-in tariffs are economic instruments, compared to command-and-control actions, such as setting quantitative goals on renewable production without attention to the costs involved. The economic actors: proprietors of investment opportunities, investors and equipment manufacturers, will respond by competitive action that will include cost-cutting in order to increase profits. Their activity will lead to an increased market share. If not the price, the supply volume will, in the ideal case, be optimised by the market. The feasibility and the social benefits will greatly depend on the effectiveness of the regulating authority.

##### *A dynamic regulatory task*

Sufficient historic evidence attests to the delicate task of the regulatory authorities in the case that they assume the responsibility to set feed-in prices. A case in point is the experience in Italy (Tomassetti, 1998) during the 90's. The prices set in 1992 by an inter-ministerial body (decision CIP 6/92) were quite stimulating, especially for small hydro power plants and cogeneration. The CIP 6/92 decision led to a landslide of registered projects. Favourable feed-in prices have not been corrected as needed, and the support system came to a standstill a few years later, when the electric power system operator, ENEL decided not to accept any new offers.

The powerful regulatory instrument of feed-in prices can easily backfire, if the authority is not well aware and prepared to act as a part of a dynamic

control loop. The real-life situation, most often governed by a superimposed political process, should be expected to destabilise the situation either by imposing rigidity or jerks. A feed-in support system should contain both elements of stability and responsive change.

The usual stability element is a provision for a long-term power purchase price. For dynamic control, the feed-in tariffs should be adjusted in time. Even though both elements existed in historic examples, their real-life performance was not always satisfactory.

### **Principles for setting the feed-in tariffs**

#### *Value of electricity or investor needs?*

Two main principles for defining feed in tariffs may be used:

- a) value of electricity + correction for externalities and strategic issues, or
- b) needs of the investors.

Closeness of both requirements is a prerequisite for a successful promotion scheme. Both points of view should be examined in the preparatory analysis. The question remains, however, which point of view should be retained in the final justification. The value of electricity is perceived as a much stronger argument in any energy-policy debate than investors' needs.

If we look at a feed-in tariff table, a clue to the point of view taken by the regulator are differences between tariffs for different types of RES. A uniform tariff across all types indicates that value principle is dominating. Differentiated tariffs for different types of RES indicate that needs of the investors are more strongly considered. Data presented in (Haas, 2001, Fig. 5) indicates both practices. In some cases, e.g. Denmark, a trend towards unification of feed-in tariffs across RES types is detected.

#### *Time dependent tariffs*

The value of electric power in a system is widely varying in time, same as for many other utilities (transportation, heating, cooling and other services). This goes even beyond the "price volatility" encountered on the electricity markets in the short term, when mostly variable production costs are at play and a daily-weekly pattern is dominating. On a longer time scale, prices should be expected to skyrocket if and when capacity falls below demand.

Many types of RES depend on the instantaneous availability of the energy source, such as wind, sunshine, tide or waves. Time-of-service considerations are not very popular in the RES community. For value-based feed-in tariffs the temporal aspect of electricity production can not be avoided, especially if a realistic comparison is to be made between such diverse situations as: run-of-the-river and accumulating hydro power plants, biomass-fired plants and severely intermittent sources as wind. CHP as an RES-assimilated type of electricity production has distinct advantage in this respect, as it relies on fuels

and, in temperate and cold climates, the maximal heat and electricity demands coincide.

RES and CHP, in any case under regulatory scrutiny, are important for long term stability of electricity markets, when and if the market share of these technologies exceeds the marginal few percent. Regulatory actions should reflect the full strategic value of electricity produced. This includes responsiveness to demand changes, including such minimal attention to system integration issues as scheduling maintenance outages and providing rapid repair, especially during high demand periods. Time-of-service tariffs can assist significantly in this direction.

#### *Diversity of potential and scope of feed-in tariffs*

The feed-in tariffs as the support instrument of choice for the next period in Slovenia, should be defined for the range of energy sources that qualify. The reverse is also obvious, that economic potential and sheer viability of renewable sources will depend on the support instruments.

In Slovenia several types of RES are of immediate interest. There is still some potential for hydro power plants (small and medium sized, up to 30 MW); also biomass (wood) fired power plants, preferably as cogeneration units, are feasible. Wind power potential has not been sufficiently investigated and bio-gas potential is obviously under-utilised. It is particularly in this new development areas that details of the support scheme are decisive. Theoretical or technical potential of wind power certainly exists, but economic feasibility of large-scale penetration is questionable. A conflict of interest between environmental protection and wind power development is also in sight.

The other major potential towards sustainable energy policy is development of CHP, particularly for space heating. In several cases even existing heating networks rely on heat-only gas-fired boilers.

No official target is set for development of RES and/or CHP in Slovenia. It is expected that a National Energy Programme will be developed according to the Energy Act, and that it will establish goals in these sectors. Also, reaching the Kyoto targets, confirmed by the recent ratification (June 2002), will require a shift towards less carbon intensive electricity production.

### **Feed-in tariffs based on electricity value**

#### *Previous experience*

A feed-in tariff has been used in Slovenia for the last 10 years. All small power plants (up to 10 MW) were eligible to conclude a contract with the local utility company and sell excess electricity at a relatively favourable price. A two-position tariff was used, with peak and off-peak prices, same for all types of small power plants.

Due to this feed-in tariff arrangement and soft loans available in the early 90's for small hydro power plants, the early 90's witnessed a boom of small hydro construction. Some examples of crude construction, slack environmental inspection and

alleged excessive profitability of some plants led to a reversal of public opinion support for small hydro.

On the other hand, investors have also experienced consequences of deficient legal and political framework. As an example, in a financial environment with almost two-digit inflation, the government failed to update the feed-in tariff levels from late 1998 through early 2002. By early 2002 in real terms the feed-in price lost 30% of the value as set in 1998.

#### *Economic basis of feed-in tariffs*

New feed-in tariffs were to be established according to one of the two principles:

- (strategic) value of commodity (including externalities), and/or
- revenue needs of the investors and operators. Both points of view should normally be investigated.

The following components of the value of electricity produced from RES (or in CHPs) were considered:

- current (market) and long term value of electric power in the system,
- compensation for network relief and auxiliary services,
- premium for reliability, long term security of supply and lower environmental impacts.

In addition to these components, which should be considered for all types of qualified electricity production, development of QP may be beneficial for industrial (technological), employment or other environmental and social reasons. These items are project specific and should be dealt with separately.

#### *Current and strategic value of electricity*

Electricity market opening in Europe revealed gross overcapacity. During the last 3 to 4 years in Continental Europe and Scandinavia the electricity prices on the power exchanges (Nordpool, APX, PLX and emerging other exchanges) are, except on rare occasions, reflecting the variable operating costs only. Incumbent utilities cope with this situation in different ways. In many cases they are able to cross-subsidise production for the transmission and distribution charges (probably the case in Germany, Austria etc.), and/or they have to, at least temporarily, renounce their capital gains. National legislation based on EU directives allows relief for "stranded investments". There is little doubt that over the next decade, the effective electricity prices will approach levels reflecting full costs, including recovery of capital investment.

There is relatively good agreement in the recent literature used in European studies about the technologies of large-scale electricity production and the full production costs ("Shared Analysis", (European Commission 1999); Lorenzoni and De Paoli (Lorenzoni, 1999), "Green Paper" (European Commission, 2000; Capros, 2000)). The more recent study was

used (European Commission), from which Table 1. is derived.

Table 1: Expected full production costs for electricity

Operating hours	€/MWh			
	Austria	Italy	Germany	average
7000	44,1	41,5	41,5	42,4
5000	50,6	50,6	46,7	49,3
2500	70,0	71,3	71,3	70,9

Note: An inflation factor of 1,297 was used between the € values for 1990 (original data) and 2001.

A base load price of approximately 40 €/MWh may be estimated from the Table 1 data. Instead, the table data were used directly as a yardstick for a time-differentiated feed-in component of long-term electricity cost estimate. This component of the feed-in price may be dubbed: "long term strategic value of electricity".

A different, complementary rather than conflicting, point of view is presented in (Cremer, 2001). It is expected that marginal costs of generation will reach 30 €/MWh in Germany by the year 2005 in and Poland by the year 2010, and stay in Italy at approximately 34 €/MWh.

#### *Bonus for network relief*

Distributed generation will require, in principle, less network capacities than centralised generation. Network capacities relate to investment costs as well as operating costs, including some of the auxiliary (system) services. Any such savings should be considered as a monetary bonus for distributed generation. An equitable analysis should consider several details, such as: Is the network cost relay avoided (in view of existence of the network)? Is the network cost avoided in each individual case?

It is recommended (IJS, 2001) that a bonus be awarded for distributed generation related to the feed-in point. A bonus can be claimed for the network costs between the very-high voltage level (it is at this level that electricity exchanges conceptually operate), and the point or level at which the flow is always "down", i.e. toward the customers. Any costs involving "upward" transmission of electricity should be assumed by the generator. This logical and equitable position is not favourable for some renewable sources, such as wind power, which will often be located in remote areas and in concentrations grossly exceeding local consumption.

For the majority of practical cases the applicable level is medium voltage (in Slovenia nominally 1-35 kV, now being standardised to 20 kV). The bonus for this level was estimated from relevant components of the fees for the use of networks, at 5,8 €/MWh, average over time.

In the distribution networks it is the maximum load that is functionally responsible for most of the costs. In a time-differentiated feed-in tariff this means that the bonus for feeding into the grid at high load hours should be much higher than the off-peak bonus. A

ratio of approximately 5:1 was proposed, based on a tariff study (IJS, 1993)

*Second best approach to external costs of electricity production*

The importance of the political position taken by the EC in 2001 regarding external costs of electricity production (Busquin, 2001) is hard to overemphasise. The position, based on extensive research of external costs of electricity production chains (ExternE, 2001), is formally incorporated into the *acquis* through rules on allowable state aid for production from renewable sources and CHP (European Community, 2001). The maximal acceptable level of subsidy is 50 €/MWh, but has to be, in principle, confirmed by country specific evaluation of externalities. The subsidisation of RES and CHP is clearly stated (Busquin, 2001) only as “second best” approach to a more direct one: internalisation of externalities according to the “polluter pays” principle. The “first best” approach is so far politically unfeasible.

Some generally accepted guidance to the level of one component of externalities, that of CO<sub>2</sub> emissions, is available in Slovenia. A CO<sub>2</sub> levy is currently applied, as part of other taxes on fuels, at the level of approximately 13,5 €/ton CO<sub>2</sub> (3 Slovenian tolar per kg CO<sub>2</sub>). A standard figure for carbon intensity of electricity, 0.44 kg CO<sub>2</sub> / kWh is also used, reflecting approximately both the CO<sub>2</sub> emissions from the reference production plant, a gas fired combined cycle plant, and the average carbon content of electricity production in Slovenia. Monetary equivalent of this is 6 €/MWh, or one-eighth of the guideline value.

Several externalities besides CO<sub>2</sub> emissions should be considered. In the ExternE study, greenhouse gases external effects for coal fired plants were approximately one third of all externalities. (This is the total that supports the proposed upper limit of 50 €/MWh.) There are also positive externalities of production from renewable resources. A value of 8.2 € was proposed to compensate externalities besides CO<sub>2</sub> emissions. Total subsidy for all unaccounted externalities of 14.2 €/MWh was proposed to tilt the uneven playing field in favour of renewable sources compared to large-scale central production of electricity from non-renewable resources. This proposed level is less than one third of the guideline value.

*Recommendations*

The preparatory study for the government decision on the feed-in prices (IJS, 2001) includes the results of considerations as described above for a unique feed-in tariff for all electricity produced from all RES. For CHP the proposed feed-in price is lower. The avoided externalities component is included in the price only proportional to the “net primary energy savings” compared to the reference fossil plants: CCGT for electricity and condensing boilers for heat. For small units, a single year-round tariff is proposed, whereas for plants in excess of 1 MW, a time-dependent tariff is recommended.

The proposed feed-in tariff was commented by an evaluation of the probable investor's point of view; i.e. by estimated profitability of typical QP projects.

A careful consideration of the investors' and regulatory risks was proposed. Investors are to be given adequate assurance, by a long-term contract or equivalent, of the real value of feed-in tariffs, in view of the inflation which is expected to remain at substantial level for some years to come. Regulatory risk is mainly an excessive feed-in price, possibly leading to excessive support of QP and consequently to an unstable investment process. Considering the difficulty of decreasing nominal feed-in tariffs after they have been set (witnessed by the Italian example), the regulatory risk can be mitigated by allowing automatic erosion of the real value of the feed-in tariff, if price levels are not re-confirmed and corrected. It was proposed that a maximal 3% real price erosion is built into the system. This may be a reasonable compromise between two points of view of the price risk problem.

In addition to the components taken in consideration (long term value of electricity, network relief bonus, compensation for externalities), it may be desirable that certain types of RES or other QP are supported at a higher level, for merits such as social, regional development or research and industrial development interests. It was proposed that such additional support, generally within the range between 6 and 12 €/MWh (except for photovoltaics, where a much higher overprice is accepted), may be granted on a project basis or for a program of similar projects. Any such additional support would have to be conditioned on perfect environmental acceptability of the project or program.

**Government decree on feed in prices**

The government ruling on feed-in prices for qualified production of March 2002 includes a Decree on the rules for setting feed-in tariffs, with a standard power purchase agreement, to be offered by the network operator, and a Decision on prices. The prices are to be reviewed at least annually.

Feed-in prices are determined as annual average price for each type of qualified production. This is at a variance with the proposed guiding principle, that all renewable sources be initially treated on an equal basis, with possible deviations at the individual project or programme basis.

The producer can opt for a time-dependent tariff (two daily periods, three seasons). A sample of the annual prices is given in Table 2.

Profitability for the plants with the assumption of constant feed-in prices (no price erosion) is presented in Figure 3. For some types the estimated straight IRR is very high, indicating paybacks in the order of two or three years.

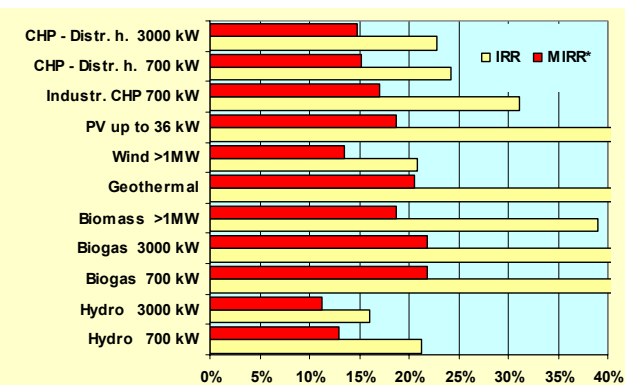
The Decree offers an alternative to electricity sale to the network operators. A producer can sell electricity on the market and claim a premium at the amount of the feed-in price as in Table 2., less an implied standard value of electricity of 3.56 c€/kWh.



Table 2: Feed-in prices for electricity, Slovenia 2002

Power plant size	c€/kWh			
	up to 36 kW	up to 1 MW	1 to 10 MW	> 10 MW
solar	28,47	6,24	6,24	6,24
biomass	+	7,13	6,91	6,91
wind	+	6,47	6,24	-
hydro	+	6,24	6,02	-
geothermal	+	6,24	6,24	6,24
CHP for district heating	+	5,94	5,72	-
municipal waste	+	5,50	5,28	-
industrial CHP	+	5,50	-	-

Notes: + not specified, same as for larger size; - not available



Notes: IRR: internal rate of return, MIRR: modified internal rate of return, implied reinvestment rate: 8% p.a.

Fig. 1. Estimated profitability of qualified production of electricity in Slovenia, feed-in prices of 2002

## Conclusions

Work on definition and justification of feed-in prices has been based on the concept of a strategic value of electricity fed into the grid by qualified producers of electricity (RES + CHP), and a bonus transfer payment for externalities not accounted for in competing large-scale production form fossil fuels. This point of view is considered as more favourable than the argument of investors' needs.

The government decree of March 2002 completes a legal framework for support of renewable sources of electricity and CHP on the basis of regulated feed-in prices. The European legal background for such arrangement has been approved by a decision of the European Court on the case of feed-in prices in Germany. No use is made of a more recent position of levelling the playing ground by accounting for externalities in a "second best" approach (Busquin, 2001).

The response of existing qualified producers has been favourable, as the feed-in price has been brought to a level as it has been in 1998 and a more stable legal framework is provided for the future.

Whether the arrangement, especially the long-term stability of economic conditions for investors, is satisfactory can not yet be estimated with any certainty. Immediate price levels seem sufficient, but it remains to be seen whether the administrative details and perceived political risks will be acceptable. It is noted that the government is yet to launch a promo-

tion campaign, except for wind power. (Wind power siting proposals have encountered less than enthusiastic response from the nature protection circles.)

The author proposes further inquiry into the regulatory dynamics of support schemes for renewables and CHP. As with other regulatory situations, only a well designed and sensitive regulatory process can yield results that would approach an optimal trajectory into a more sustainable energy system.

As for development of technologies, for mature technologies, such as for hydro power plants and CHP, a steady stream of improvements and new quantitative developments is desired. Sufficient impulse is needed for emerging technologies, such as wind energy, high efficiency biomass and possibly photovoltaics.

The regulator should in our opinion assume a "cybernetic" position within the control loop seeking a (moving) target, alas, with many error inputs and constraints.

## References

- Busquin, P. (2001), press conference, July 20, 2001, <http://europa.eu.int/comm/-research/press/2001/pr2007en.html>
- Capros, P. et al. (2000): *Note on the impact of Fuel Taxation on Technology Choice*, Athens November 2002, published as: Annex 2, of the Green Paper (European Commission (2000))
- Cremer, C., Bradke, H. (2001) *Options and potentials for European electricity imports: a German perspective*, ENER Bulletin, 24.01, pp. 31-35; [www.eu.fhg.de/ENER/](http://www.eu.fhg.de/ENER/)
- European Commission (1999), "The Shared Analysis Project: European Union Energy Outlook to 2020." *Energy in Europe*. Special Issue, European Commission, Directorate General for Energy. [www.shared-analysis.fhg.de/](http://www.shared-analysis.fhg.de/).
- European Commission (2000), "Green Paper": "Towards a European strategy for the security of energy supply", COM(2000)769
- European Commission (2001), *Community guidelines on State aid for environmental protection* (O.J. C 37, 3.2.2001)
- EXTERNE (2001), several works, overview abstract presented in (Busquin, 2001)
- Haas, R. ed. (2001): *Rewiew Report on Promotion Strategies for Electricity from Renewable Energy Sources in EU Countries*, June 2001, TU Wien, Compiled within the cluster "Green electricity", <http://www.tuwien.ac.at/iew/elgreen/>
- IJS (1993), *Vrednotenje električne energije v Sloveniji* (Value of electric power in Slovenia, in Slovene), Final report, IJS-DP-6713, for EGE-RI (Electricity Research and Engineering Co., Maribor, SLO), Ljubljana, SLO, March 1993.
- IJS (2000), *Development Programme of Slovenia for Qualified Producers of Electricity*, (in Slovene; *Razvojni program Slovenije na področju kvalificiranih proizvajalcev električne energije*), Final report, Institute "Jožef Stefan", IJS-DP-8388, for the Ministry of Economic Affairs of Slovenia, Ljubljana, SLO, March, 2001
- IJS (2001), *Sklep vlade o odkupnih cenah za električno energijo od kvalificiranih proizvajalcev električne energije* (A government decision on feed-in prices for electricity from qualified producers of electricity, in Slovene), Final report, Institute "Jožef Stefan", IJS-DP-

8501, (For Ministry of environment and physical planning), Ljubljana, SLO, November 2001.

Lorenzoni A. ed. (1999): *Economia e politica delle fonti rinnovabili e della cogenerazione*, Franco Angeli 1999; cited and excerpted in European Commission (1999), vol. 8, Ch. 4: The Expected Impact of Electricity Regulation, pp.153-170

Tomassetti, G. (1998) *The Italian Experience on CHP Development*, Internal report to the project "CHP development programme for Slovenia", (For Ministry of Foreign Trade, I), February 1998.

## Is current RES support policy in the Czech Republic sufficient and efficient? Barriers and challenges

Jaroslav Jakubes and Miroslav Maly, *Enviros*<sup>104</sup>, Prague, Czech Republic

**Keywords.** Czech Republic, RES promotion, RES policy, Feed-in tariffs, energy legislation

**Abstract.** Although the potential of renewable energy sources (RES) in the Czech Republic is limited by natural conditions, the share of RES could be at least doubled by 2010. In the last few years, some important steps have been made in the Czech Republic towards more intensive RES support. A National programme for Promotion of Energy Efficiency and a Wider Use of RES was introduced, new energy legislation adopted and preferential feed-in tariffs for RES electricity implemented. However, in the context of EU accession, there are still several missing pieces in the puzzle of the Czech RES support policy that would make it efficient and sufficient in terms of meeting EU legislative requirements and contributing to EU targets regarding RES utilisation.

### Introduction

The non-renewable energy sources make up 98% of total primary energy sources (TPES) in the Czech Republic. The current share of utilisation of renewable energy sources (RES) is low partly due limited natural conditions, however, it is also a result of energy policy in the previous period, which preferred the concentration of energy sources to decentralised generation and also provided subsidies to non-renewable energy sources (coal, nuclear).

### Current status and potential of RES utilisation in the Czech Republic

In 1999, the National Energy Efficiency Study for the Czech Republic was elaborated with the support of the World Bank and the Dutch government [1]. The study contains a detailed analysis of RES potentials in the Czech Republic and one of the major outcomes of the Study was the Renewable Energy Action Plan including the list of concrete policy actions, ready for implementation [2].

#### *Current utilisation of RES*

According to updated results of the above-mentioned study, the total renewable energy production in 2001 was approx. 26 PJ (of which 70% was in biomass and 17% in hydropower), representing altogether approximately 2% of TPES. This level is below an average figure in Central and Eastern European countries (and less than in three comparable Central European countries - Hungary, Poland and Slovakia) and well below an average figure in EU countries. Regarding RES electricity, its share in gross national electricity consumption was 4.2% in 2001.

Biomass is the major RES used in the Czech Republic. Biomass fuels include mainly wood waste

---

<sup>104</sup> Formerly SRC International CS.

with a slowly growing share of liquid biofuels<sup>105</sup> and solid biofuels (woodchips, woodpellets).

Hydropower is already developed given the natural conditions of the Czech Republic with a total installed capacity of 2,147 MW and 2.46 TWh of generated electricity in 2001 (or 4.1% of total generation). Other renewable energy sources (wind, solar, geothermal) have made a marginal contribution only.

Wind energy utilisation is still rather symbolic (total installed capacity is approx. 7.5 MW) and had a stagnating tendency in the last years due to unfavourable economic conditions (low feed-in price of electricity, grid connection issues).

#### *Potentials of RES*

The available potential<sup>106</sup> of RES utilisation in the year 2010 identified in the above-mentioned study is 97.0 PJ, which corresponds to the share of 7.0% of TPER, while an economic potential<sup>107</sup> of RES utilisation in 2010 is estimated as high as 39.3 PJ which corresponds to the share of 3.6% in TPER.

Biomass represents nearly 90% of the total potential and consists mainly of agricultural waste (straw) and forest exploitation products (wood and wood waste).

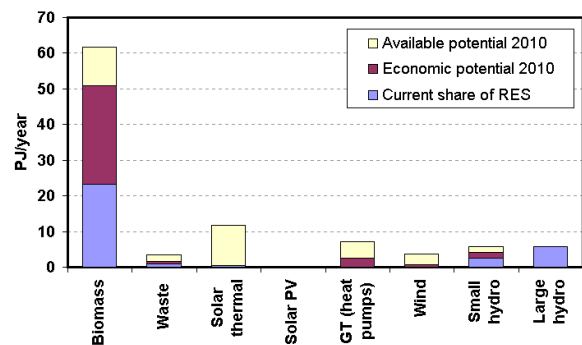
The potential for large hydro is already utilised<sup>108</sup>, there still exists a potential for further extension of small hydropower capacity, however, the unit costs of new small hydro plants rather high as the most profitable projects have already been developed so the further development will be possible only under more favourable conditions for RES electricity. In the case that the conditions allow full utilisation of the potential for small hydro, production of electricity from these sources could be increased by approx. 0.45 TWh.

According to several sources of information, the available potential of wind energy varies between 1.2 (conservative estimates) up to 5 TWh per year (optimistic estimates). The economic potential will significantly depend on conditions for RES electricity.

This means that the conventional energy sources will still play an important role in the Czech Republic in the future, however, if the barriers to RES development are removed, the contribution of renewables to the national energy balance could be at least doubled by 2010.

The Figure 1 summarises the current share and potentials of RES in the Czech Republic by type of RES.

Fig. 1. Current share and potentials of RES in the Czech Republic by type of RES



#### **Current status of RES support policy framework in the Czech Republic**

During last few years, the policy and legislative environment has changed significantly in the Czech Republic in the context of the EU accession and economic transformation.

##### *New National Energy and Environmental Policy documents*

In the year 2000 a new national Energy Policy was approved by the Government. This policy document indicates the priorities and key issues to be resolved including creation of a well-functioning, non-discriminatory, transparent and motivating system of support to energy savings, effective use of renewable energy sources and CHP.

The Energy policy document also sets a target for the share of RES on TPES to about 3-6 % in 2010 and to about 4-8 % as of the year 2020. The national Environmental Policy approved in 2001 sets a similar RES target for the year 2010: 4-6% of RES on TPES. However, these targets are not binding. Both policy documents call for setting necessary legal framework for promotion of RES.

##### *New energy legislation*

In the year 2000, two key legislative documents have been adopted - new Energy Act (Act No. 458/2000 Coll.) and Energy Management Act (Act No. 406/2000 Coll.).

The *Energy Act* sets the framework for business activities in the energy sector. The Energy Act also specifies the RES and CHP generated electricity purchase obligation for grid operators and provisions for priority access to the grid for electricity generated from RES and CHP. Despite the fact that access to the grid is a necessary condition for investors of RES it is not sufficient for future efficient use of RES potential. Nevertheless the Act does not specify other necessary tools for promotion of RES.

The *Energy Management Act* is implemented since 1<sup>st</sup> January 2001. The Energy Management Act deals specifically with the ways to promote energy efficiency such as minimum energy efficiency requirements, conditions for thermal and technical properties of buildings, energy efficiency labelling, local and regional energy planning, energy audits and co-

<sup>105</sup> Biodiesel had the share of 4.9% in the total diesel fuel sold in the Czech Republic in 1999.

<sup>106</sup> The available potential is the technical potential that could be utilised by currently available technologies, taking into account administrative, legislative, environmental and other constraints.

<sup>107</sup> The economic potential is estimated on the basis of given economic criteria.

<sup>108</sup> New large hydropower plants would be connected with significant negative environmental impact which is not acceptable.

generation of heat and power (CHP). In the fields directly related to RES utilisation, the Energy Management Act is further supported by legislative decrees specifying a definition of RES (Decree No. 214/2001 Coll.), and conditions for buy-out of electricity from RES and CHP (Decree No. 252/2001 Coll.). The latter decree contains detailed provisions on obligatory purchase of electricity from all RES with exception of hydro power plants above 10 MW. The Energy Management Act also calls for setting the National Programme for Promotion of Energy Efficiency and a Wider Use of Renewable and Waste Energy Resources.

*National Programme for Promotion of Energy Efficiency and a Wider Use of Renewable and Waste Energy Resources [4]*

The National Programme was approved by the Czech government in late 2001. The National Programme is prepared for four year period by the Ministry of Industry and Trade, in collaboration with the Ministry of the Environment and has to be regularly assessed at least once every two years.

The National Programme is a framework programme and lists the priority tools for promotion of RES. One of the major tools is the annual State Programme for Energy Efficiency and Use of Renewable and Waste Energy Resources.

*State Programme for Energy Efficiency and Use of Renewable and Waste Energy Resources*

The State Programme deals with the various types of support in the form of subsidies provided by the State budget and State Environmental Fund for relevant programmes including support to RES. In case of RES all types of RES are supported through investment grants and soft loans. The support is provided on the basis of the results of the bidding procedure. As the budget is limited only part of bids can be rewarded by the subsidy grant.

*Feed-in tariffs for RES electricity*

Following the requirements of the Decree No. 252/2001 Coll. on conditions for buy-out of electricity from RES and CHP the new increased feed-in tariffs for RES electricity have been introduced by the price decision of the Energy Regulatory Office 1/2002 since January 2002 (for more details see chapter on RES Electricity support).

*Flexible mechanisms*

The Czech Republic is a signatory of the Kyoto Protocol to the UN Framework Convention on Climate Change. In accordance with the Kyoto Protocol, on January 7, 2002, the Ministry of the Environment (MoE) approved the "Rules of the Ministry of the Environment for Joint Implementation Projects in the Czech Republic". This is one of the necessary conditions for participation on the Kyoto flexible mechanisms through implementation of concrete projects. Among the potential projects for JI there are mostly projects using RES (biomass boilers, landfill gas etc.).

## RES electricity support

The most important step done in last two years is the adoption of the Energy Law, which contains RES electricity purchase obligation for grid operators and provisions for priority access to the grid for electricity generated from RES and CHP. On the other hand, there still exist relatively strict technical conditions for grid connection and for application of feed-in tariffs (contracted supply versus time variation of RES supply).

Introduction of increased feed-in tariffs for RES electricity by the price decision of the Energy Regulatory Office 1/2002 is another important step. Compared to previously applied uniform feed-in tariff for electricity from all small sources (1.10-1.13 CZK/kWh, i.e. 3.5-3.7 c€/kWh), the conditions for RES electricity have improved significantly. However, there are still several issues related to the feed-in tariffs to be resolved in order to introduce this support mechanism into real life. The following table gives an overview of the currently applied feed-in tariffs in the Czech Republic.

Tab. 1. Feed-in tariffs for RES electricity valid since 1<sup>st</sup> January 2002

	CZK/kWh	c€/kWh
original feed-in tariff		
all sources	1.13	3.7
new feed-in tariffs since 1.1.2002:		
small hydro	1.5	4.9
wind	3.0	9.8
biomass	2.5	8.2
biogas	2.5	8.2
geothermal	3.0	9.8
solar PV	6.0	19.6

## Biomass and biofuels market support

The support of energy utilisation of biomass and production of biofuels is based on various subsidy schemes for individual projects rather than on system-wide measures. Individual projects for biomass utilisation (particularly small biomass district heating sources) are supported by the State Environmental Fund in the framework of National Programme for Promotion of Energy Efficiency and a Wider use of RES.

It is worth to mention an extensive biodiesel market in the Czech Republic - current production capacity is approx. 60 thousand tons per year. This capacity was developed using subsidies in the framework of the so called "Oleoprogram" of the Ministry of Agriculture in the years 1992-1996. The current support for production of biofuels (biodiesel, bioethanol) is provided mainly through the schemes of the Ministry of Agriculture for support of non-food agricultural production (subsidy for local production of rapeseed methylester is 3 CZK/kg) and through exemption from excise tax. Both solid and liquid biofuels are also supported by lower taxation..

## Taxation measures

### *Tax incentives*

The following tax incentives relevant to RES are currently applied in the Czech Republic:

- Reduced import duties and VAT rate (5% instead of 22%) for selected RES equipment (small sized equipment).
- Five-year tax relief (income and property) for investment in RES.
- Reduced VAT rate of 5% for biomass fuels
- Reduced excise tax on biodiesel.

### *Introduction of carbon/energy tax*

Several studies/analyses initiated by the Ministry of the Environment analysing possible introduction of energy / carbon tax have been already carried out. According to the Ministry of the Environment an introduction is desirable but due to negative position of the Ministry of Finance that is strictly against increase of taxation burden, the Czech Republic is currently in "wait for common EU approach" position and the introduction of carbon/energy tax is unlikely before the EU accession and also before a common EU policy in this field is implemented.

The Ministry of the Environment have also prepared a scheme consisting of a levy on electricity sales at a rate of 0.6% of the final energy prices to support investment in renewable energy ("green cent" scheme). This scheme have been widely discussed but not accepted so far.

## Barriers and issues to be resolved

Despite large progress in RES promotion in the Czech Republic in last 2-3 years there are still many barriers and issues to be resolved. These are briefly discussed below.

### *Statistics on RES*

Even if the Czech Statistical Office has started data gathering and processing on RES, the results showed that more efforts are needed for getting reliable data. Data is needed for assessment on the success of various tools and programmes and also for setting new targets.

### *Feed-in tariffs*

As it was outlined above, the application of feed-in tariffs have some (rather significant) drawbacks and there are several other issues that have to be solved:

- Given the currently applied procedure of setting regulated electricity prices (prices are set once a year by the Energy Regulatory Office), the feed in tariffs have to be updated or reconfirmed each year. The application and the price level of feed-in tariffs is therefore not guaranteed for the future years which creates significant uncertainty for investors into RES electricity projects. This has to be resolved otherwise the feed-in tariffs would be ineffective.

- It is not clear if the feed-in tariffs will be supported by another measure such as regional quota system or green cent scheme. Currently, the increased costs for power distributors resulting from purchase of RES electricity are projected into end-user prices. This is, however, possible only when the share of RES is low and the electricity market is not fully liberalised. It will be necessary to develop and introduce supplementary measures to feed-in tariffs that would address the issues of increased costs of regional distributors resulting from buy-out of RES electricity and the issues of regional differences (the power distributors in regions with higher RES electricity production will be disadvantaged). The long-term approach to RES electricity and the support tools should be introduced into new energy policy document that is to be elaborated in 2003 and also in the new Energy Act.
- It will be necessary to introduce scheme for the guarantee of origin<sup>109</sup> of RES electricity according to requirements of RES-E Directive 2001/77/EC. This should be a priority issue.

### *Biomass market support*

Given the potential of biomass, it would be necessary to set clear priorities reflecting market conditions and potentials of different RES: 1. biomass, 2. RES-E, 3. other RES.

Utilisation of biomass for heating should be supported by stimulation of development of solid biofuels market (wood pellets, briquettes, woodchips), increase of information and awareness and support for identification and development of the projects rather than via the project investment subsidies. The Government should consider introduction of the following subprogrammes of the National programme for promotion of EE and wider use of RES:

- Start-up support for increase of production capacities of refined biofuels (woodpellets, briquettes) and marketing of these fuels.
- Support to local producers of biomass end-use equipment (R&D, marketing).
- Support to biomass logistics and trade of biofuels.
- Support to biomass project development (project identification, feasibility studies, energy audits).

### *Inconsistent and non-binding policy targets*

The targets for RES development in the Czech Republic are not consistent as they are specified in various policy documents and it is not clear what target is the priority one:

- 3-6% in 2010 – State Energy policy;
- 4-6% in 2010 – State Environmental policy;

---

<sup>109</sup> Currently, some of the power distributors have already started their RES electricity marketing schemes without guaranteeing the origin of the electricity to the final customers.

- 3.2 % in 2005 - National Programme for Promotion of Energy Efficiency and a Wider Use of RES;
- 5.1% RES-E in 2005 - National Programme for Promotion of Energy Efficiency and a Wider Use of RES.

In addition, the targets are more or less proclamative and non-binding as there is no clear commitment to meet them and there are no monitoring, evaluation and enforcement instruments for meeting the targets.

It will be necessary to set realistic, clear and binding national targets compatible with EU goals for the share of RES and RES electricity in energy supply and to introduce the system of monitoring of the meeting of the targets. These targets should be preferably incorporated into the new energy policy document. It will be also necessary to negotiate and agree the targets with Commission of the EU in order to reflect natural conditions in the Czech Republic but to contribute to common EU RES targets.

#### *Legislation*

The current energy legislation does not fully reflect the latest developments in EU - there are missing links and provisions related to EU directives (RES-E Directive) and EU RES targets. This should be incorporated into new Energy law that is under preparation.

#### *Tax support*

The current tax incentives apply to very small capacity units (i.e.: hydropower lower than 0.1 MW, wind: 0.075 MW). The government should consider extending the scope of these measures to higher capacity equipment (hydropower: 10 MW, wind: 1 MW)

Inconsistencies in tax support of biofuels (proposals for removal of preferential excise tax for biodiesel) should be resolved and put in line with long term priorities and with other support schemes to keep the biodiesel market alive.

#### *Institutional and policy framework*

An implementation of the State Programme for Energy Efficiency and Use of Renewable and Waste Energy Resources in the field of RES is done by 2 government agencies – the Czech Energy Agency and the State Environmental Fund. This reduces the efficiency of the State Programme management and confuses the bidders for grants as different criteria are applied by these two agencies for evaluation of bids. A uniform system with one responsible agency and uniform criteria for bid evaluation will be necessary.

It is necessary to finalise development of framework for JI projects (establishment of national registry and setting the national target in AAU units).

The country does not participate in EU Altener programme. Participation in Altener should be reconsidered.

#### **References**

1. *National Energy Efficiency Study for the Czech Republic* (1999). ECN for the World Bank.

2. *Renewable Energy Action Plan - Policy Action Plan for Promotion of Renewable Energy in the Czech Republic to 2010* (1999). ECN for the World Bank.
3. *Energy policies of IEA countries Czech Republic 2001 review* (2001). IEA/OECD, Paris
4. *National Programme for Promotion of Energy Efficiency and a Wider Use of Renewable and Waste Energy Resources*. Resolution of the Government of the Czech Republic No. 1079/2001, October 2001



## Renewable energy supporting strategies in Poland

Anna Oniszk-Popławska EC Baltic Renewable Energy Centre EC BREC/IBMER, Warsaw, Poland

### Keywords.

Legal framework, policy, strategies, acts, ordinances, development programs, renewables in Poland.

### Abstract.

The most important document for development of renewable energy sources in Poland is the 'Development Strategy of Renewable Energy Sector', which was adopted by the Parliament in August 2001 sets forth ambitious goals. Renewable energy is a cross-sector issue referring to environmental, economic and social aspects thus various governmental bodies undertake steps, which aim at their support. Unfortunately the so far legal framework for RES development is not coherent. This article presents the existing legal framework for RES in Poland.

### Introduction to RES policy in Poland

The present contribution of renewable energy to the primary energy balance has been estimated at 2.5%, ca. 104 PJ (EC BREC 1999). Wood has the biggest share from among all renewables. The current structure of utilisation of energy produced from renewable sources is following:

biomass	98.05%
hydro power	1.82%
geothermal energy	
wind power	0.02%
solar energy	0.01%.

The Polish policy regarding renewable energy is guided by the accession to the EU and the adherence to the Kyoto Protocol. Renewable energy was not a priority of the energy policy in the 90-s, as attention was given to restructuring of the fossil fuel sector, improving the structure of the primary energy production towards increased use of natural gas and decreasing energy consumption. Renewable energy was seen in a long-term perspective. The end of 90-s is the period of increased political engagement in creating conditions for renewable energy development. The 'Resolution on Increase of Renewable Energy Sources Utilisation' 1999 approved by the Polish Parliament was a milestone. The Parliament called the Council of Ministers to prepare the 'Development Strategy of Renewable Energy Sector' in Poland and its harmonisation with the energy and environmental policies of the country. The Minister of Environment took over the task of preparing the strategy on behalf of the Council of Ministers. Along with preparing the 'Strategy', the government was working and approving of other key documents, such as: 'Assumptions of the Poland's Energy Policy to 2020' approved in 2000, 'The Second Environmental Policy', and also 'Strategy of Sustainable Development of Poland to 2025'.

The documents concerning different aspects of RES utilisation have been initiated by different Ministries, unfortunately till now there is no coherence of actions undertaken by them. This is due to the fact

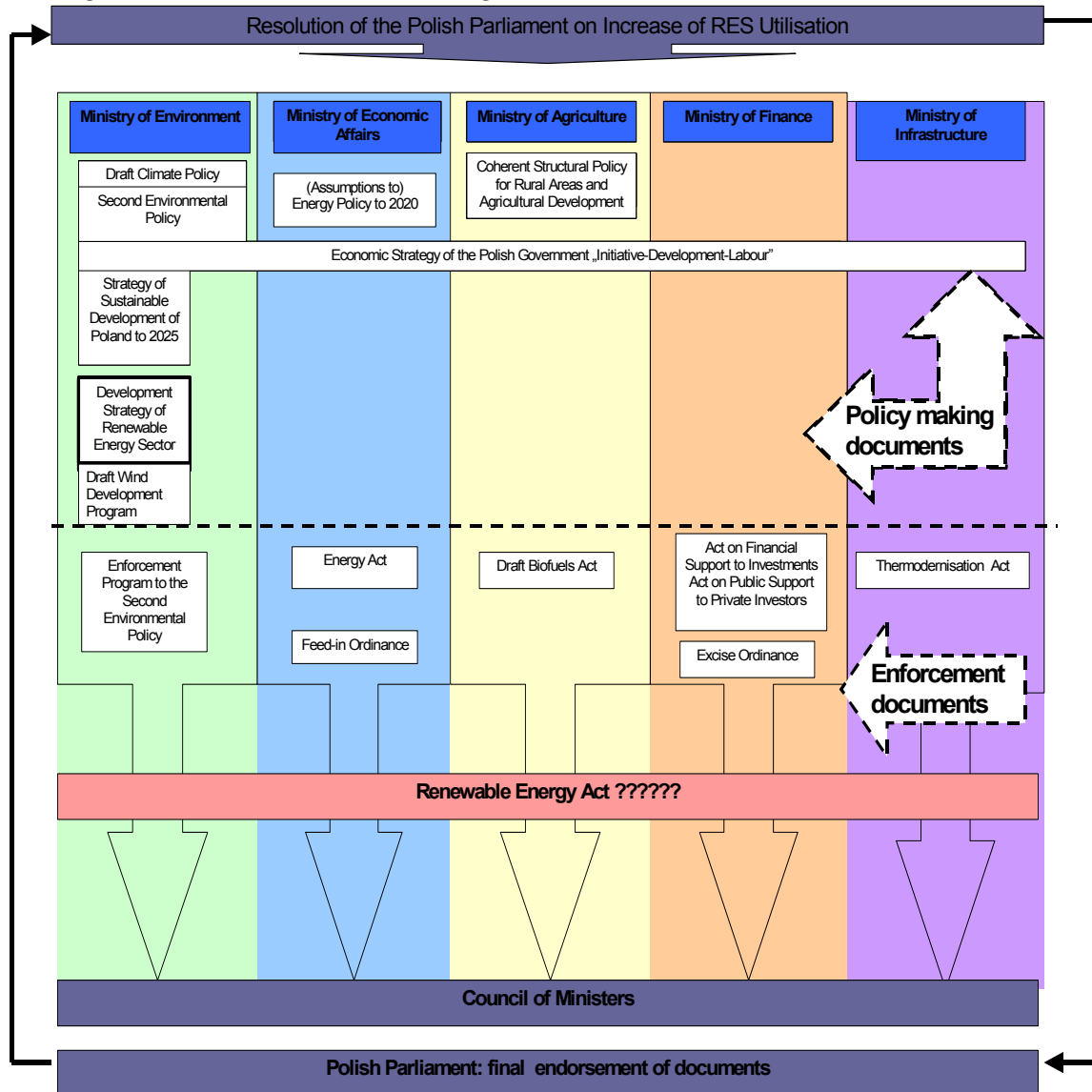
that the Ministries have different responsibilities and sometimes opposing interests.

The Ministry of Environment: is responsible for the state policy in the area of climate change, sustainable development; environmental protection, which includes the management of RES. From the point of view of this Ministry the most important is the "green" aspect of the renewable energy utilisation. The Ministry of Economic Affairs is responsible for the energy policy and general regulation of the energy sector. Its general task is to develop and implement state policy in the area of economic development. From the point of view of the Ministry of Economic Affairs renewables are important as far as impact on the energy prices, stability of electricity grid, creation of new job places, domestic production of installations are concerned, whereas the Ministry of Finance about the state of the domestic budget, the Ministry of Agriculture about the development of rural, poor areas and giving additional income to farmers and stimulating agricultural production and the Ministry of Infrastructure about adjusting Polish infrastructure to the EU modern standards. The decentralised energy generation based on RES is not as important as larger scale projects based on utilisation of conventional fuels.

The documents prepared by these Ministries can be divided into policy making documents and enforcement documents. Such documents include: Climate, Environmental, Energy, and Agricultural Development Policies. Strategies, concern specific topics of the Country's development such as: sustainable development or economy. Economic Strategy of the Polish Government 'Initiative-Development-Labour', endorsed in 2002 is the most important document for the Polish government in the election period 2001-2005, it also mentions utilisation of renewable energy, as one of the main areas of modernisation of economy. Another group of documents are enforcement documents *i.e.* acts and ordinances. Acts have the legal power by stipulating rules which must be followed. Following documents can be included in this group Acts on: Energy, Thermomodernisation, Financial Support to Investments and Public Support to Private Investors. The ordinances, of which the Feed-in and Excise Ordinances are examples, have weaker political meaning than Acts because they are issued directly by the Ministries and the legislative way to change them is much shorter than in case of Acts.

There is a number of incoherence between different documents, the only chance to harmonise actions undertaken by different institutions in the area of renewable energy utilisation is elaboration of the Renewable Energy Act, which should provide a real legal framework (not only directions and wishful thinking like in case of policies and strategies) and lasting stability (not like in case of ordinances) for investors. When prepared and endorsed it will build a real foundation for stable development of renewables in Poland. In this article the documents presented in the Figure 1 are described in more detail.

Figure 1 Official documents concerning RES



### Environmental policy

Environmental obligations, which Poland undertook by participating in EU accession as well as being a party to the Climate Convention are the driving factors for development of renewables. Currently ‘Climate Policy’ for Poland is being prepared. The emission reduction units available for sale (considering the fact that some percentage of units must be treated as country’s reserves) are now under the process of discussion and are estimated between 50 to 130 mln tonnes of CO<sub>2</sub> reduction units between 2008-2012 (Bodnar et al 2002). The official figures are under the process of negotiation. The possible incomes to the budget have been estimated at the 5-20 USD/t CO<sub>2</sub>.

The ‘Second Environmental Policy’ endorsed by Government in 2000 and by the Parliament in 2001 sets out the goal for renewables at doubling the participation of RES in the energy balance to 2010.

Currently the implementation program to the above mentioned document is in the phase of preparation.

In 2000, the Council of Ministers adopted the document ‘Development Strategy of Renewable Energy Sources’, then it was endorsed by the Parliament in 2001. Approving the ‘Strategy’ by the Council of Ministers took place after a long, lasting several months discussion, which led to a fundamental change in the government’s approach to the possibility of utilising renewable energy sources. Approving the goals stated in the ‘Strategy’ is of historical significance not only for development of renewable energy but also for the energy policy. It is the first policy document relating to the whole renewable energy sector, pointing the basic goals and conditions for its development to 2020. It was elaborated in response to the EU White Paper ‘Energy for the future: Renewable Energy Sources’. The ‘Strategy’ is a pioneer document but also the first policy document of such importance in Central and Eastern Europe. The ‘Strategy’ calls for 7.5% contribution of renew-

able energy to the primarily energy of the balance in 2010 and 14% in 2020, as development targets for renewables. Such increase of renewables in the energy balance would require production of 340 PJ of 'green energy' in 2010, *i.e.* growth by 235 PJ compared with 1999, assuming the energy needs of Poland in 2010 at 4570 PJ. Such targets oblige the government to take actions to actively support renewables in Poland. The amounts are ambitious: in comparison to *ca.* 2.5% share in 1999, it means triple increase in utilisation of energy produced from renewable sources during the coming ten years.

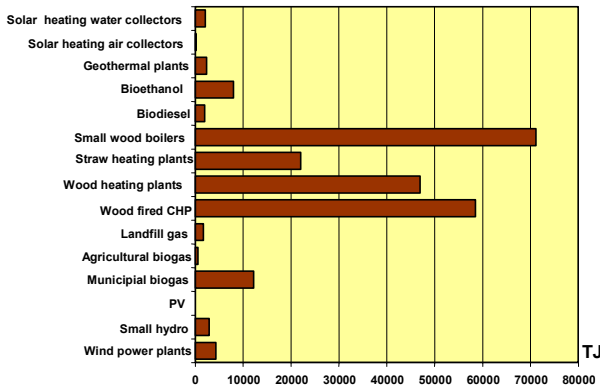


Fig. 2. Renewable energy production in 2010, TJ as per the Strategy

Activities aimed at securing dynamic development of renewable energy in Poland constitute an integral part of the 'Strategy', the most important ones are the following:

- Formal and legal activities facilitating access to renewable energy sources; *iter alia* preparation of the RES Act,
- Economic instruments increasing feasibility of renewable energy sources utilisation and supporting,
- Development of new systems, *e.g.* Tradable Green Certificates,
- Education and promotion activities for renewable energy sources and international co-operation.

In the Strategy it was emphasised that the development of renewable energy sector creates opportunities especially for the local communities as regards local energy independence, regional development and creation of new jobs as well as environmentally-friendly modernisation of infrastructure, diversification and decentralisation of the energy sector. It was estimated that achieving the goals outlined in the Strategy will lead to reduction of greenhouse gases emissions by around 18 million tonnes and creation of additional 30-40 thousand jobs (in direct employment) annually.

It has been assumed that the 'Strategy' will be implemented by means of enforcement programs for particular sources of renewables. In order to execute the provisions of the Strategy, the Ministry of Environment prepared the first midterm enforcement 'Wind Energy Development Program 2002-2005', it

is (2002) still in the phase of interministerial consultations. This is a model program which opens the door for the preparation, endorsement and execution of other development programs (small hydro, solar, geothermal and biomass energy). The 'Strategy' shows moderate growth of the wind energy sector in Poland to 2010 by 600-1,600 MW. This means that the contribution of wind turbines to the total final energy balance in Poland would not exceed 2.0%. Wind energy will, however, be one of the most significant factors for obtaining a general quantitative objective in production of 'green' electricity to 2010. Growing interest in the preparation of wind energy projects has been observed among investors and developers in Poland. Only last year the number of installations has grown from 16 turbines in 2001 to 41 turbines (in 20 places), the total capacity growing from 4,7 MW to 28,2 MW. Implementation of projects is being withheld by uncertainty regarding electricity buyback rates. In addition, investors' activities and expectations of local governments have encountered legal and bureaucratic barriers. The 'Program' is to create economic and legal conditions, initiate successful projects and prepare local governments, industry and investors for the growth of the number of wind energy projects thus permitting not only a reasonable increase of the amount of electricity produced (particularly after 2005) but also the attaining of maximum social, economic and environmental benefits.

### Energy policy

The documents concerning renewables in the energy policy are the responsibility of the Ministry of Economic Affairs. Due to the fact that Poland is in the EU accession process the documents are constantly being changed. This year (2002) both the amendments to the Energy Policy as well as to the Energy Act have been prepared.

'Assumptions of the Energy Policy to 2020'. The Assumptions define the basic elements of the energy policy, based on an analysis of the present state and the expected future development of the energy sector. The main goals are similar to the EU energy policy objectives (security of supply, competitiveness and environmental protection). In the 'Assumptions' the role of renewable energy sources in the development of infrastructure was mentioned. RES are described here as having very low technical potential, and their utilisation as 'insignificant to 2020'. 'Amendments to the Assumptions of the Energy Policy to 2020' have been prepared in 2002. RES are mentioned many times there but on the other hand a lot of attention is given to utilisation of natural gas, which is the main competitor of RES on the energy market. The 'Assumptions' are not coherent with the already accepted by the Parliament 'Development Strategy of Renewable Energy Sources'.

The document says 'the years 2001-2010 are very unfavourable for development of RES due to slow economic development, surplus energy capacities, decreasing demand for energy'. According to the

document priority should be given to biomass and feed-in ordinance should be supported by TGC.

The '*Energy Act*', is the basic legal framework for the regulation of the energy sector. It provides the necessary legal conditions for businesses in the field of energy production, transmission, distribution and trade. Furthermore, the '*Energy Act*' defines the responsibilities of the Ministry of Economic Affairs and Energy Regulation Office (URE). Under the law, energy enterprises have to sign contracts for the delivery of electricity, gas and heat, and have to follow the third party access rule. As far as renewables are concerned the Act: 1) gives definition of renewable energy, 2) obliges the Ministry of Economic Affairs to issue a Feed-in ordinance for renewables, 3) obliges communes to prepare energy plans. '*Draft Amendments to the Energy Act*', 2002 are currently under the final phase of amendment process. Compared with the former version following changes have been made: 1) the definition of renewable energy source is changed in accordance with the EU Directive, 2) it obliges the Ministry of Economic Affairs to elaborate Feed-in ordinance in which following information will be given: types of installations, technical and technological parameters of RES, level of electric energy purchases, which are obligatory for energy utilities.

Apart from the '*Energy Act*' there are ordinances which deal with different issues of electricity market. One of them concerns the obligation for utilities to purchase electricity from RES. '*Feed-in Ordinance*' sets the obligation for energy enterprises dealing with trade of electricity and heat to purchase electricity or heat from non-conventional and renewable energy sources connected to the common electricity grid. Electricity and heat generated from waste incineration are not included in this definition. The obligation to buy electricity from non-conventional and renewable energy sources (including CHP generation) shall be fulfilled if the quota of these sources in the total annual sale of electricity of the energy supplier is not less than percentages presented in the figure below.

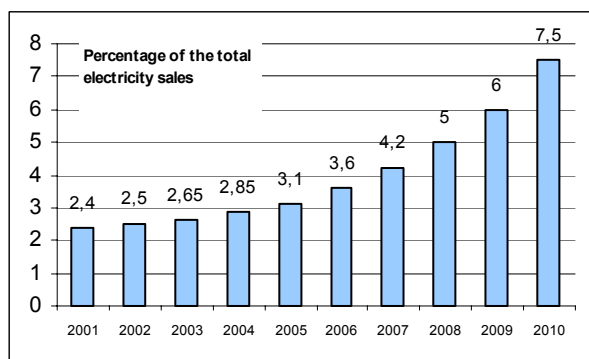


Fig. 3. Graphical presentation of the feed-in quotas for energy utilities.

The idea of this ordinance was to encourage energy utilities to gradually increase the participation of renewables in their overall energy balance. Again it does not specify the level of buyback rates for the renewable electricity, thus increasing level of uncer-

tainty among investors. Currently the prices are negotiated on the case by case basis and they vary from 4-7 c€/kWh. The ordinance is incomplete for two reasons: 1) does not specify the level of punishment for non-compliance, 2) it is not supported by a trading scheme, such as for instance tradable green certificates, which would enable paper trading of produced 'green' electricity between utilities. Currently the Regulation Office is evaluating the first year of the functioning of the ordinance (URE 2002) and investors are impatiently waiting for the announcement of the punishment fee. If the punishment fee is high enough it will result in dynamic development of investments, if not it will be just a 'dead' regulation not stimulating growth of renewables.

'*Thermomodernisation Act*' stipulates that conversion of installations based on fossil fuels to installations based on renewables along with energy efficiency measures is considered as thermomodernisation. The Act stipulates principles of financial contribution for investments from this area. The thermomodernisation premium is paid in the amount of ca. 25% of the investment credit, after finalising the whole investment. The financial resources are given from the state budget.

### Agricultural policy

Currently the '*Biofuel Act*' is under preparation. This legal document is an initiative of the Ministry of Agriculture and the draft is in the process of interministerial consultation. The production of biofuels is regulated by the 'domestic limit', which will increase every year up to 5% of biodiesel and 4.5% of bioethanol in the overall transport fuel market which makes 260,000 tonnes of bioethanol and 400,000 of biodiesel. The production of bioethanol will require additional production of 0.8 million tonnes of rye and 2.4 million tonnes of potatoes. The production of biodiesel will induce additional production of 0.7 million tonnes of rape. The Biofuels Act has been a subject of criticism of the Minister of Finance, who is reluctant to release biofuels from excise duty payments (currently the excise is approximately 45% of the petrol price) as it can cause serious losses to the already very much strained state budget. Additional arguments against the '*Biofuels Act*' is that there is no Polish norm for biodiesel, which can be a reason for the misuse. The future of the Biofuel Act remains unknown but it has been evaluated as a step in a good direction.

### Financial Policy

'*Act on Financial Support to Investments*' was endorsed in March 2002 as a response to dropping level of investments in Poland. Its goal is to increase the attractiveness of investments in Poland as well as the number of new job places. The Act assumes support for environmental investments inter alia for RES installations. The financial support is predicted both for the private investor and the municipality and is given by the Ministry of Economic Affairs. The total amounts to be distributed are specified each year by the Budget Act. In the area of environmental protec-

tion financial means for 50 investments have been predicted each year amounting to 0.5 mln € per investment. The public support to private investors varies for different territories of Poland, regulated by a separate Ordinance. There are specific criteria for evaluation of the investment proposal, which shall be performed by a special committee. The proposals are to be submitted for a tender to the Ministry of Economic Affairs twice a year.

'*Excise Ordinance*' stipulates the level of excise for different goods every year. It sets the electricity excise at the level of *ca.* 0.56 €/kWh, i.e. 10% of the electricity price paid by the final consumers. The Ordinance of the Ministry of Finances exempts electricity generated by RES installations as well as pumped-storage power stations from payment of this tax. Because the excise tax applies to utilisation of fossil fuels in the energy sector and due to the fact that renewables are exempted, it can be considered as a form of a carbon tax. Carbon tax is one of the chief supporting mechanisms enabling to internalise external costs of energy production from fossil fuels thus making renewables more competitive on the energy market. As far as excise tax in reference to biofuels is concerned biofuels would be *ca.* 45% times cheaper and much more competitive on the market if they were released from payment.

### Financial Institutions

Additionally to the legal instruments financial incentives to support RES are necessary. The institutions, which support the development of RES financially are following:

- EcoFund's income comes from the national debt-for-environment swap. One the priorities of this fund is support to RES (currently biomass is the top priority- already 85 MW projects got the support and additional 120 MW are underway). No support is given to small hydro. The total so far subsidies amount to *ca.* 250 mln EUR, the number of installations being 720.
- National Fund for the Environmental Protection and Water Management generates its income from the pollution levies. In 2001 30 investments were supported the majority being solar and biomass.
- Regional Funds Fund for the Environmental Protection (they spend app. 85 mln EUR (Swiderska et al 2001) to support air protection investments every year)

Bank for Environmental Protection also has significant financial support to RES investments.

### Summary

The most important document for development of renewable energy sources in Poland is the 'Development Strategy of Renewable Energy Sector', which was adopted by the Parliament in August 2001 sets forth ambitious goals. The main legislative initiative so far lies on the side of the Ministry of Environment. With this renewable energy policy document, Poland

is ahead of the other countries of Central and Eastern Europe. Important barriers to development of RES in Poland relate to:

- Insufficient attention to renewable energy both with decision-makers and other stakeholders;
- Difficult co-operation between administrative units (e.g. ministries) on renewable energy policy;
- Clashes of interests between different renewable energy lobbies and with electricity generators and distributors (utilities);
- Contradictory policy documents on renewable energy;
- Subsidies for conventional fuels and coal mines, and over-production of electricity,
- Difficulties to find proper targeted financial resources for development of RES (current problems with the budget, accessibility of EU funds after 2004).

### References

- Bodnar, P., Barthold, H. and Hauff, J. (2002) CO<sub>2</sub> Emissions Trading in Central and Eastern Europe- a Business Opportunity for Companies in the Energy Sector.
- Council of Ministers (1997) Energy Law OJ 1997, No 54, item 348.
- Council of Ministers (1998) Act on Support to Thermo-modernisation Investments. OJ 1998, No 162, item 1121.
- Council of Ministers (2000) Development Strategy of Renewable Energy Sector.
- Council of Ministers (2002) Initiative-Development-Labour Economic Strategy of the Governmental Coalition. SLD-UP-PSL.
- Council of Ministries (2002) Draft Act on the Amendments to the Energy Law.
- Council of Ministers (2002) Act on Financial Support to Investments OJ 2002 No 41, item 363.
- Council of Ministers (2002) Act on the Change of the Revenue Act. OJ No 19, item 185.
- EC Baltic Renewable Energy Centre (EC BREC) (1999) Economic and Legal Aspects for the Utilization of RES in Poland. Expertise for the Ministry of Environment. Warsaw.
- EnergSys (2002) Draft of the Climate Policy and Options for its Realisation. Warsaw.
- Ministry of Economic Affairs (1999) Assumptions to Poland's Energy Policy to 2020.
- Ministry of Economic Affairs (1999) Electricity and Heat from Unconventional Energy Sources OJ 1999 No 13, item 119.
- Ministry of Economic Affairs (2000) Assumptions to Poland's Energy Policy to 2020. Warsaw.
- Ministry of Economic Affairs (2000) Ordinance on Feed-in Obligation for Electricity from Unconventional and Renewable Energy Sources, Cogeneration as well as Heat from Unconventional and Renewable Energy Sources OJ 2000 No 122, item 1336.
- Ministry of Economic Affairs, Energy Regulation Office (URE) (2002) Evaluation of Realisation and Amendment to the Assumption of the Energy Policy of Poland to 2020. Document endorsed by the Council of Ministers on 02.04.2020. (the MEA homepage URL: [http://www.mg.gov.pl/struktur/energet/de\\_ocena02/menu.htm](http://www.mg.gov.pl/struktur/energet/de_ocena02/menu.htm)).

- Ministry of Agriculture (2002) Draft Act on Organisation of the Market for Liquid Biofuels and their Components. (webpage of the Ministry of Agriculture URL: <http://www.minrol.gov.pl/Publikacje/ekopaliwa/projekt.pdf>).
- Ministry of Environment (2000) Second Environmental Policy [Druga polityka ekologiczna].
- Ministry of Environment (2000) Strategy of Sustainable Development of Poland to 2025. (webpage of the Ministry of Environment URL: [http://www.mos.gov.pl/mos/publikac/Raporty\\_opracowania/strategia/index1.html](http://www.mos.gov.pl/mos/publikac/Raporty_opracowania/strategia/index1.html)).
- Ministry of Environment (2001) Draft of the Wind Energy Development Program for 2002-2005. webpage of the Ministry of Environment URL: [http://www.mos.gov.pl/oze/dokumenty/program\\_ewi.pdf](http://www.mos.gov.pl/oze/dokumenty/program_ewi.pdf)
- Ministry of Finance (2002) Ordinance of the Excise Tax. OJ No 27, item 269.
- Polish Parliament (1999) Resolution of the Polish Parliament on the Increased RES Utilisation (Polish Monitor No 25, pos. 365).
- Świderska, A., Broniewicz, E., Demianowicz, A., Burzyński, R., and Dobrogowski, R. (2001) Sources of Financing of Environmental Investments in Poland. Wydawnictwo Ekonomia i Środowisko: Białystok.
- URE Energy Regulation Office (2002) URE Biuletyn 3/2002 Annual Report 2001. (homepage of URE URL: [http://www.ure.gov.pl/informacje/r9\\_32002.html](http://www.ure.gov.pl/informacje/r9_32002.html)).



## Programme

### Thursday 6 June, 2002:

**(Chair: Reinhard Haas)**

9:00	<b>Opening of the ENER Forum</b>
9:10	<b>Sustainable energy systems in the Sixth RTD Framework Programme</b> Domenico Rossetti, DG Research, EC
<b>Session 1: Promoting RES in Europe – The state-of-the-art (Chair: Poul-Erik Morthorst)</b>	
9:35	<b>The EC's directives on RES: a basis for a broader market penetration</b> Karl Kellner, DG TREN, European Commission
10:05	<b>Survey on and review of promotion strategies for RES in Europe</b> Reinhard Haas, Energy Economics Group, Austria
10:45	<b>Coffee break</b>
11:10	<b>Transaction Cost of Regulations to foster RES</b> Ole Langniss, Lund University, Sweden
11:50	<b>Regulatory and Institutional Innovation for the Promotion of Renewable Energy Use review</b> Reinhard Madlener/Eberhard Jochem, CEPE Switzerland
12:40	<b>Discussion</b>
13:00	<b>Lunch</b>
<b>Session 2: Pros and Cons of various promotion strategies (Chair: Hans Auer)</b>	
14:00	<b>Success criteria for quotas based on TGCs</b> Poul-Erik Morthorst (RISOE), Denmark
14:40	<b>Feed-in tariffs versus quotas : how to promote renewables and stimulate technical progress for cost decrease ?"</b> Philipp Menanteau, IEPE, Grenoble, France
15:20	<b>Tea break</b>
15:50	<b>Tradable Green Certificates or Feed-in tariffs? What is more effective for promoting RES-E?</b> Claus Huber/Thomas Faber, Energy Economics Group, Austria
16:30	<b>The European Dimension of National RES-E policy making – The Dutch experience</b> Emiel van Sambeek (ECN), The Netherlands
17:10	<b>Green electricity certificates in Belgium</b> Aviel Verbruggen, UFSIA, Antwerpen, Belgium
17:30	<b>Closing of the day</b>
19:30	<b>Dinner</b>

### Friday 7 June, 2002:

9.00	<b>Leaving REFIT for the green certificate market: a jump in the dark?</b> Arturo Lorenzoni, IEFIE; Milano, Italy
<b>Session 3: Promoting RES: stakeholders point-of-view (Chair: Wolfgang Eichhammer)</b>	
9:40	<b>The effect of renewable energy supporting strategies on society. The issue of public acceptance</b> Andreas Wagner, EWEA; Germany
10:20	<b>Coffee break</b>
10:50	<b>Experience of Spanish independent Renewable energy developers and investors</b> Manuel Bustos, Spanish Renewable Energy Association-(APPA), Spain
<b>Session 4: Promoting RES in accession countries (Chair: Zoltan Vass)</b>	
11:40	<b>Information Disclosure on Electricity Generation</b> Diana Urge-Vorsatz, Central European University, Budapest, Hungary
12:10	<b>How to justify and define a feed-in-tariff? : A debate and decisions in Slovenia, 2002</b> Mihael G. Tomsic, Jozef Stefan-Institute, Slovenia
12:30	<b>Lunch</b>
13:30	<b>Promoting RES in Hungary: The regulators point-of-view</b> Peter Kaderják, Hungarian Energy Office, Hungary
14:00	<b>Is current RES support policy in the Czech Republic sufficient and efficient? Barriers and challenges</b> Jaroslav Jakubes, SRCI, Prague, Czech Republic
14:30	<b>Coffee Break</b>
15:00	<b>Renewable energy supporting strategies in the Baltic Sea Region. The Polish example</b> Anna Oniszk-Popławska, EC BREC, Poland
15:30	<b>Final Discussion and Closure of the Forum</b>

## List of Participants

*Amon, Ada*, Energia Klub, Budapest, Hungary  
*Andras, Juhasz*, Vertis Finance Co., Hungary  
*Auer, Hans*, EEG Vienna University, Austria  
*Balajka, J.*, Profing Ltd., Slovakia  
*Bela, Györgyi*, MAKK - Hungarian Environmental Economics Center, Hungary  
*Betz, Regina*, FhG-ISI, Karlsruhe, Germany  
*Bustos, Manuel*, APPA Spanish RES Association, Barcelona, Spain  
*Bühler, Axel*, GE Wind, Germany  
*Csillag, Zoltán*, Ministry of Economics, Hungary  
*De Paoli, Luigi*, University L. Bocconi, Milan, Italy  
*Eichhammer, Wolfgang*, Fhg-ISI, Karlsruhe, Germany  
*Fucskó József*, MaKK - Hungarian Environmental Economics Center, Budapest, Hungary  
*Graenitz, Ilona*, GLOBE Europe, Brussels, Belgium  
*Haas, Reinhard*, EEG Vienna University, Austria  
*Horvath, Laszlo*, Energy Institute "Hrvoje Pozar", Zagreb, Croatia  
*Huber, Claus*, EEG Vienna University, Austria  
*Jakubes, Jaroslav*, ENVIROS CZ, Prague, Czech Republic  
*Kaderják, Peter*, Hungarian Energy Office, Hungary  
*Kellner, Karl*, European Commission, DG TREN,  
*Kis, András*, MAKK - Hungarian Environmental Economics Center, Budapest, Hungary  
*Lach, Kata*, Central European University, Hungary  
*Langniss, Ole*, Environmental and Energy Systems Studies, Lund University, Sweden  
*Lavrov, George*, ISPE, Bucharest, Romania  
*Lorenzoni, Arturo*, University L. Bocconi, Milan, Italy  
*Madlener Reinhard*, Centre for Energy Policy and Economics, Zürich, Switzerland  
*Maly, Miroslav*, ENVIROS CZ, Prague, Czech Republic  
*Martins, Álvaro*, CEEETA, Lisbon, Portugal  
*Menanteau, Philippe*, IEPE/CNRS, Grenoble, France  
*Merse, Stane*, Energy Efficiency Center, Slovenia, Slovenia  
*Morthorst, Poul Erik*, Risø National Laboratory, Roskilde, Denmark  
*Onisk, Anna*, EC Brec, Warsaw, Poland  
*Pál, Gabriella*, Hungarian Energy Office, Budapest, Hungary  
*Rossetti di Valdalbero, Domenico*, European Commission, Research DG  
*Rosta, Ferenc*, Ministry of Economics, Hungary  
*Sambeek, Emiel van*, ECN, Petten, The Netherlands  
*Schleich, Joachim*, Fhg-ISI, Karlsruhe, Germany

*Smith, Adrian*, SPRU, University of Sussex, United Kingdom  
*Solinc, Hinko*, Slovenian Ministry for the Environment and Spatial Planning, Slovenia  
*Takács, Gabor*, Energia Klub, Budapest, Hungary  
*Tomsic, Miha*, Energy Efficiency Center, Slovenia, Slovenia  
*Ürge Vorsatz, Diana*, Central European University, Budapest, Hungary  
*Vass, Zoltan*, Energia Klub, Budapest, Hungary  
*Verbruggen Aviel*, University of Antwerp - STEM, Belgium  
*Wagner, Andreas*, European Wind Energy Association, Germany